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Study to Develop Background Information for the Direct Meat-Firing Industry

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STUDY TO DEVELOP BACKGROUND INFORMATION FOR THE DIRECT MEAT-FIRING INDUSTRY

Final Report

by

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Task No. 2

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January 1978

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DISCLAIMER

This Final Report was furnished to the U.S. Environmental Protection Agency by GCA Corporation, GCA/Technology Division, Bedford, Massachusetts 01730, in fulfillment of Contract No. 68-02-2607, Task Order No. 2. The opinions, findings, and conclusions expressed are those of the authors and not necessarily those of the Environmental Protection Agency or of cooperating agencies. Mention of company or product names is not to be considered as an endorsement by the Environmental Protection Agency.

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EXECUTIVE SUMMARY

INTRODUCTION

The large increase in the number of restaurants over the past several years is due mainly to the growth of the fast food industry. One method commonly used by this industry to prepare food is direct meat firing. The operation of a direct meat-firing unit (either a charbroiler or a barbecue) often results in considerable quantities of visible smoke (particulates) and odors (gaseous organic matter). The major objective of this report is to estimate the potential change in emissions over the next 10 years as a result of establishing New Source Performance Standards (NSPS).

POPULATION AND CHARACTERISTICS OF DIRECT MEAT-FIRING RESTAURANTS

The total number of restaurants estimated to be operating in 1977 is 356,300. Approximately 9 percent or 32,000 of these facilities use direct meat firing. Table 1 presents the geographical distribution of these restaurants in the United States. About 85 percent of the direct meat-firing restaurants use gas-fired grills, 12 percent use electric-fired grills and the remaining restaurants use either charcoal/wood grills or a barbecue. Meat consumption at a typical facility is approximately 77 kilogram (170 pounds) per day or 28.1×10^3 kilograms (31 tons) per year. Over 50 percent of the meat served is in the form of ground meat.

SOURCES AND TYPES OF EMISSIONS

The only significant source of air emissions from a direct meat-firing facility is the exhaust stack from the charbroiler or barbecue. Table 3 summarizes the emission rates for uncontrolled direct meat-firing facilities.

Emissions consist primarily of particulates and gaseous organic matter. The gaseous organic matter is responsible for the characteristic odor and is attributable to alcohols, aldehydes, organic acids, nitrogen and sulfur compounds, which are decomposition products of fat, meat tenderizer and other meat additives. Particulates are extremely small, and are typical of smoke produced by condensation of vapors.

Particulate emissions from all direct meat firing facilities are 45.7×10^6 kg (50,350 tons) per year or approximately 1,360 kg (1.5 tons) per facility per year. Gaseous organic emissions total 15.8×10^6 kg (17,370 tons) per year or approximately 454 kg (0.5 tons) per facility per year. Emissions of NO_x and SO_2 are negligible, estimated at 27.2 kg/yr and 6.8 kg/yr (60 lb/yr and 15 lb/yr), respectively, for each facility.

There is evidence that carcinogenic compounds are present in the exhaust gases from direct meat-firing operations. This subject should receive further investigation.

APPLICABLE BEST SYSTEMS OF EMISSION REDUCTION

Two systems are commercially available to control particulate emissions from direct meat-firing facilities. They are: a mist eliminator system marketed by Hardee's Food Systems under the trade name "Conqueror" and electrostatic precipitators. The Hardee's system is composed of a Monsanto Brink ® mist eliminator, mounted inside a tank housing, and a Gaylord grease extractor. Several of the units are in operation throughout the country and are capable of removing 93 percent by weight of the particulate emissions.

Electrostatic precipitators, designed by several air pollution control companies for use in restaurants, have been successfully used to remove particulates from direct meat-firing facilities. If properly designed and maintained, electrostatic precipitators have been shown to be 90 percent efficient for the removal of particles as small as 0.03 microns in diameter.

The only available method of effectively reducing gaseous organic emissions is the afterburner. In order to ensure complete combustion it is essential that the operating temperature be maintained at 760°C (1400°F). At this temperature, control efficiencies of 99 percent are possible. Two major disadvantages to using an afterburner are its cost of operation and the formation of nitrogen oxide compounds (NO_x). Operating costs of several thousand dollars per month would not be uncommon and the production of NO_x may offset the benefits gained by the reduction of gaseous organic compounds.

MODEL IV RESULTS

Results of the Model IV calculations indicate that the potential reduction of particulate emissions by application of NSPS would be 81.5 percent of the projected emissions in 1988, assuming noncompliance with existing state regulations. Emissions in 1988 are estimated to be 107,053 tons without NSPS and 19,831 tons with NSPS. If present state regulations are enforced and NSPS are not promulgated, emissions could be reduced by 88.7 percent to 12,033 tons in 1988. If state regulations are enforced and NSPS are promulgated, emissions could be reduced by 92.5 percent to 8,053 tons in 1988.

The reduction expected from NSPS for gaseous organic emissions is 86.7 percent, or 32,010 tons of potential uncontrolled emissions in 1988. If NSPS are not promulgated, gaseous organic emissions will more than double from the present day level of 1.58×10^7 kg (17,371 tons).

SECTION 1

DIRECT MEAT-FIRING - BACKGROUND

INTRODUCTION

The present trend of Americans eating more of their meals away from home has caused a large increase in the number of restaurants over the past several years. This increase is due mainly to the fast food industry. The fast food industry, as its name implies, relies primarily on quick techniques for preparing food. One of these methods commonly used is direct meat firing. The operation of a direct meat firing unit (either a charbroiler or a barbecue) often results in considerable quantities of visible smoke (particulates) and odors (organic vapors). It is estimated that approximately 9 percent (32,000) of all restaurants in the country use direct meat firing.

This report is concerned primarily with commercial sized direct meat-firing equipment and potential changes in rate of emissions over the next 10 years which could result from establishing new source performance standards (NSPS).

POPULATION OF DIRECT MEAT-FIRING RESTAURANTS

Very little information is available in the literature concerning the number of direct meat-firing facilities in the country. This industry which is characterized by numerous restaurants, large and small, throughout the country has never in the past received any national attention since it has always been considered a negligible pollution source. Because of this lack of interest, there are very few information sources for this industry. The National Restaurant Association, the industry trade group, does not even maintain records specifically relating to direct meat firing. It was, therefore, necessary to estimate the number of direct meat-firing facilities based on a directory[1] of all chain operated restaurants in the country supplemented by information available in several major city telephone yellow pages. Seattle, Washington; Jacksonville, Florida; Kansas City, Missouri; and Boston, Massachusetts were considered to be a representative cross-section of the country. This survey, plus information from the chain restaurant guide,[1] indicated that 9 percent of all restaurants use direct meat firing.

The total number of restaurants operating in 1972 according to the U.S. Department of Census was 252,876.[2] Updating this figure to 1977 by using an annual average growth rate[1] of 7.1 percent results in an estimated 356,300 restaurants operating in 1977. Direct meat-firing facilities represent 9 percent or ~32,000 units. Table 1 presents a breakdown of the number of units by each state. Figure 1 shows the geographical distribution. As indicated in this geographical breakdown, the industry is located primarily in heavily populated areas, as expected. Urban and suburban areas are prime locations for the direct meat-firing industry, especially fast food establishments.

GROWTH TRENDS

The fast growth of this industry is indicated by the increase in the number of chain operated restaurants since 1972. In 1972 there were approximately 86,000 chain restaurants. Data for 1977 show that the industry has expanded by 41 percent resulting in over 121,000 chain operated restaurants. This increase in the number of chain operated restaurants for the years 1972 to 1977 is shown in Figure 2. It is assumed that the growth rate for the direct meat-firing industry is the same as for chain-operated restaurants - 7.1 percent annually - because many chain restaurants rely on direct meat firing.

MEAT CONSUMPTION

In 1976 the total meat consumption in the United States was 12.3×10^9 kilograms (kg), (27.1 billion pounds).[3] Approximately 50 percent of all meat is consumed in the home,[4] 10 percent is consumed at schools, hospitals and institutions, and the remaining 40 percent is consumed at restaurants.[3] Using this statistical data, reports prepared for Hardee's,[5] and conversations with several direct meat firing operators,[6-11] it is estimated that a typical facility consumes approximately 77 kg (170 pounds) of meat per day or 28.1×10^3 kg (31 tons) per year. It is not possible to determine the percent contribution of the various types of meat cooked, but GCA estimates that over 50 percent of the meat served is in the form of ground meat.

TYPES OF EMISSIONS

The major emission problems associated with the industry are particulates and odor (gaseous, organic material). Particulate emissions are a result of melting of fat present in the meat during broiling. As fat drops on the radiant cooking surface it flares up to sear the meat's surface and some fat is entrained as particulate. Incomplete combustion of fat causes the characteristic odor and appearance of a typical direct meat-firing operation. A limited number of stack tests[12,13] indicate that the odor is primarily due to volatile aldehydes and that particulates are a very fine organic particulate.

In the absence of control devices, the submicron particulate emissions will often exceed local opacity regulations and may also exceed general process weight regulations.

TABLE 1. STATE DISTRIBUTION OF DIRECT MEAT-FIRING FACILITIES

	All eating places 1972	All eating places 1977*	Total direct meat-firing operations 1977†
Alabama	3,382	4,765	429
Alaska	394	555	50
Arizona	2,521	3,552	320
Arkansas	2,717	3,828	345
California	27,289	38,450	3,461
Colorado	3,238	4,562	411
Connecticut	3,754	5,289	476
Delaware	688	969	87
District of Columbia	982	1,384	125
Florida	9,958	14,031	1,263
Georgia	5,137	7,238	651
Hawaii	1,139	1,605	144
Idaho	1,153	1,625	146
Illinois	13,634	19,210	1,729
Indiana	6,019	8,481	763
Iowa	4,051	5,708	514
Kansas	3,375	4,755	428
Kentucky	3,280	4,622	416
Louisiana	4,089	5,761	518
Maine	1,452	2,046	184
Maryland	3,638	5,126	461
Massachusetts	7,374	10,390	935
Michigan	8,988	12,664	1,140
Minnesota	4,628	6,521	587
Mississippi	2,539	3,577	322
Missouri	5,943	8,374	754
Montana	800	1,127	101
Nebraska	2,092	2,948	265
Nevada	793	1,117	101

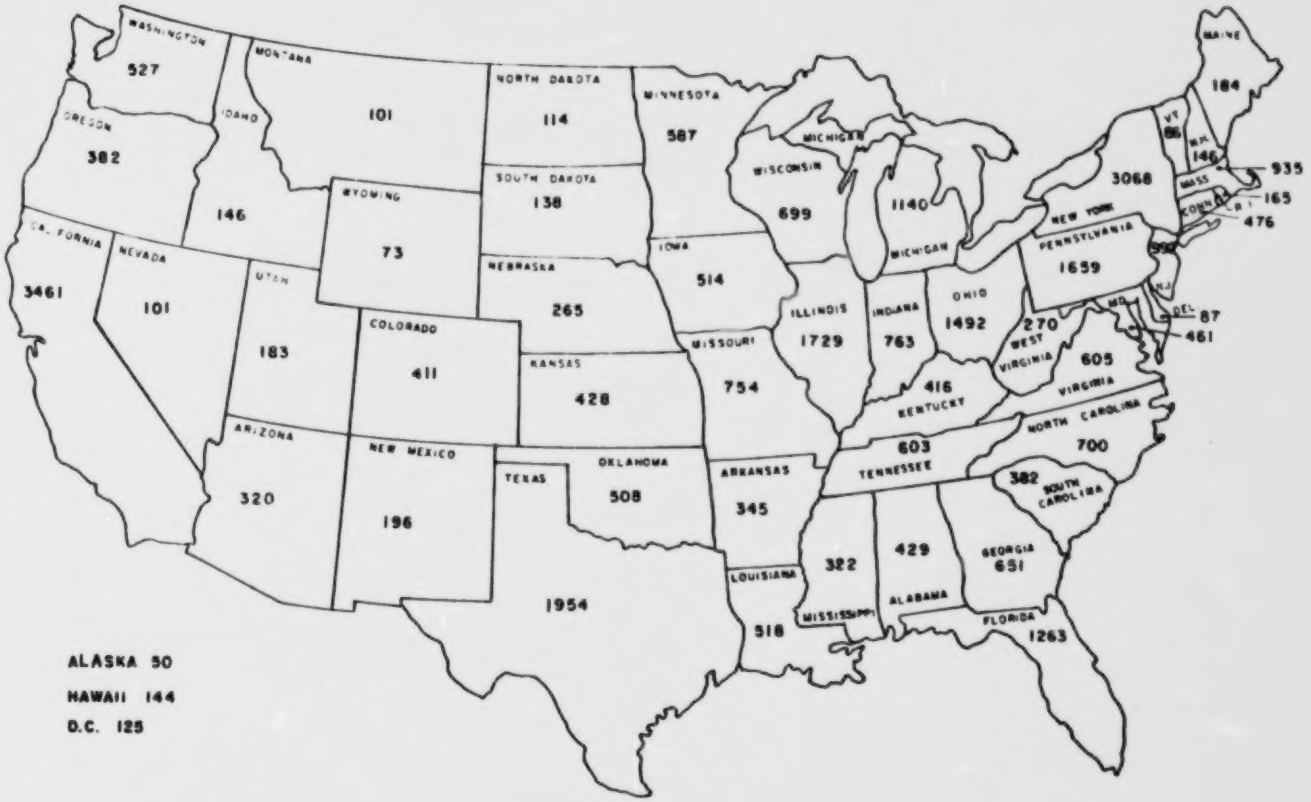
(continued)

TABLE 1 (continued).

	All eating places 1972	All eating places 1977*	Total direct meat-firing operations 1977†
New Hampshire	1,152	1,623	146
New Jersey	7,824	11,024	992
New Mexico	1,544	2,175	196
New York	24,192	34,086	3,068
North Carolina	5,522	7,780	700
North Dakota	896	1,262	114
Ohio	11,764	16,575	1,492
Oklahoma	4,004	5,642	508
Oregon	3,012	4,244	382
Pennsylvania	13,086	18,438	1,659
Rhode Island	1,301	1,833	165
South Carolina	3,009	4,240	382
South Dakota	1,091	1,537	138
Tennessee	4,757	6,703	603
Texas	15,407	21,708	1,954
Utah	1,443	2,033	183
Vermont	681	960	86
Virginia	4,774	6,727	605
Washington	4,158	5,859	527
West Virginia	2,126	2,996	270
Wisconsin	5,513	7,768	699
Wyoming	573	807	73
Total	252,876	356,300	32,068

*Figures updated from 1972 Census figures using 7.1 percent average annual growth rate.

†Figures based on 9 percent of all restaurants having direct meat firing.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OREGON
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ARIZONA
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MAINE
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146
MASS
935
CONN
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R.I.
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NJ
MD
DEL
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461
ALASKA 50
HAWAII 144
D.C. 125

Figure 1. Distribution of direct meat-firing facilities.

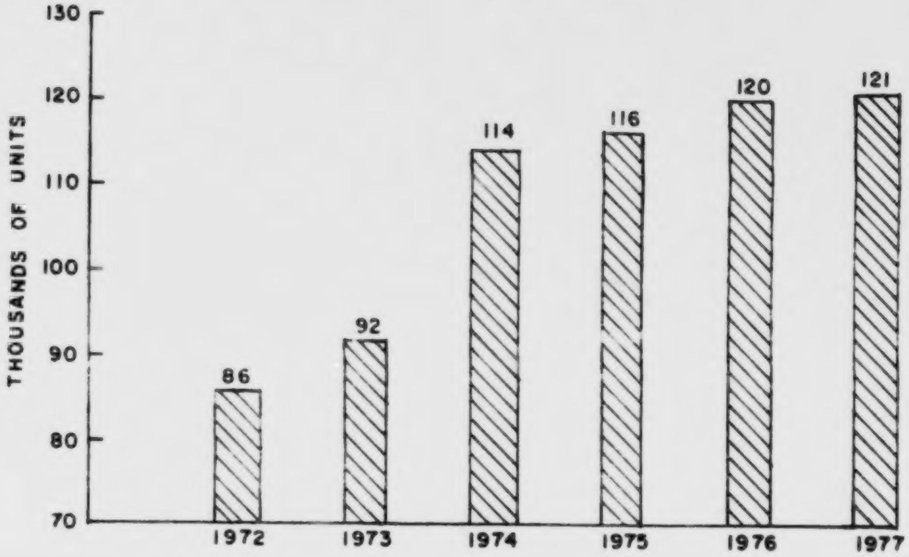


Figure 2. Growth of chain-operated restaurants.[1]

SECTION 2

SOURCES AND TYPES OF EMISSIONS FROM DIRECT MEAT FIRING

The term direct meat firing describes the two cooking practices commonly used by fast food restaurants as well as full service restaurants. The most common method of direct meat firing is the charbroiler, while a small number of restaurants rely on a barbecue.

CHARBROILERS

Charbroilers used in commercial restaurants consist of three major components: the grill, a high temperature radiant surface and a heating source. A typical charbroiler is shown in Figure 3.

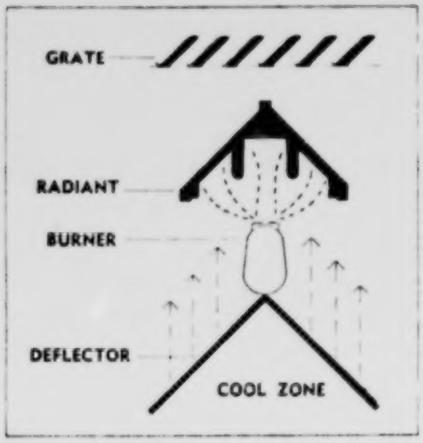
The grill is usually constructed of cast iron and is grated to hold the meat while exposing it to the heating source. Several types of grills are available; some have wide spaces between grates, others have smaller spaces but a larger number of grates. Several types have a pitched grease trough on each grate blade which provides for fat runoff and reduced flare-up; this often reduces generation of particulate emissions.

The average size commercial charbroiler has a cooking surface of approximately 0.9 meters^2 (m^2) (10 feet^2 (ft^2)), although this typically ranges from 0.28 to 2.23 m^2 (3 to 24 ft^2). Fast food restaurants may use two or more of these units.

The high temperature radiant heating surface can be constructed of several different types of materials. "Lava rocks," granite stones, metal and ceramic are some of the more commonly used materials.

Three different methods of heating charbroilers are used. The most common method, which accounts for 85.6 percent of direct meat-firing installations, is gas.[14] Electricity is the next most common method, accounting for 11.9 percent.[14] Wood or charcoal-fired charbroilers are sometimes utilized, but account for less than 1 percent of all direct meat-firing units.[15] Table 2 presents the estimated number of charbroilers in operation during 1977 and their method of firing.

Gas-fired units are designed so that only a portion of the cooking surface can be used if so desired. Small units may only have two or three burners while large units may have as many as 20 burners. The capacity of each burner is usually in the range of 3,500 to 4,000 kilocalorie/hr (kcal/hr) (14,000 to 16,000 British thermal units/hr (Btu/hr)).


GRATE
RADIANT
BURNER
DEFLECTOR
COOL ZONE

Char-Radiant Principle

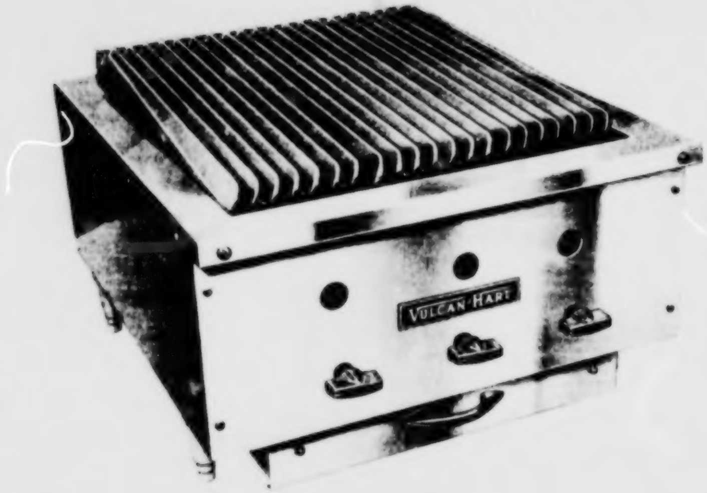

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Figure 3. Typical charbroiler.

TABLE 2. CHARBROILERS IN OPERATION DURING 1977

Method of firing	Number of units
Gas (natural or propane)	27,400
Electric	3,800
Wood/charcoal	300

Electrically-operated charbroilers are similar to gas-fired units. Small electric units usually have two heating elements, while larger units may have up to 10 elements. Each element consumes about 2 to 3 kilowatts of electricity per hour.

Only very limited information is available on units fired by both wood and charcoal. One charcoal fired, full service restaurant has a charbroiler approximately 6 feet in length which consumes 54.5 kg (120 lb) of charcoal per day.[10] No data are available on wood-fired units.

BARBECUES

The second method of direct meat firing used by some restaurants is the barbecue. It is estimated that 1.6 percent of all direct meat firing facilities or 500 restaurants use the barbecue for cooking meat.[1] Barbecues are used to bring out natural meat flavor and also the flavor and aroma derived from burning hardwood. The most common barbecue is the rotary spit and the oven, although barbecue pits are sometimes used.

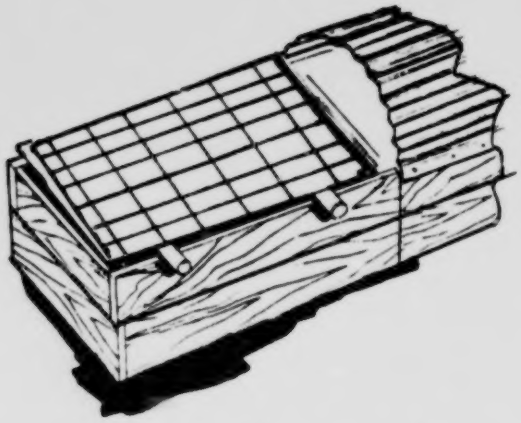
Rotary Spits and Barbecue Ovens

The rotary barbecue (See Figure 4) consists of a bed of charcoal or wood with an overhead electrically driven rotary spit. The capacity of the spit can range from a few pounds to several hundred pounds. This process is similar to a charbroiler except that the meat is suspended higher over the heat source and is constantly turned, resulting in the smokey flavor common to barbecues.

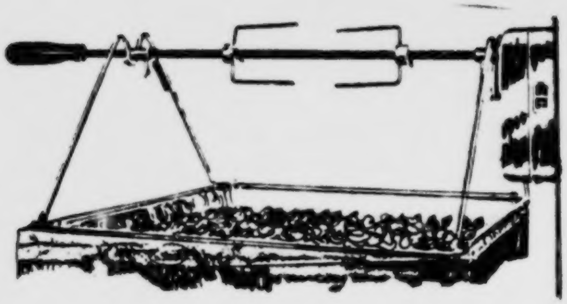
The barbecue oven also shown in Figure 4, relies on a hardwood fire located at one end of the oven. Heat and smoke are drawn to the cooling chamber by the natural draft created by a damper control in the chimney. Temperature in the cooking chamber is maintained at 93.3 to 121.1 degrees Celsius (^{o}C) (200 to 250 degrees Fahrenheit (^{o}F)) by closing the damper for reducing temperature, or by opening the damper and adding additional wood to increase temperature. Meat is placed directly on a steel mesh grill and permits drippings to pass to the bottom of the cooking chamber. Drippings are removed after a sufficient quantity has accumulated.

Barbecue Pits

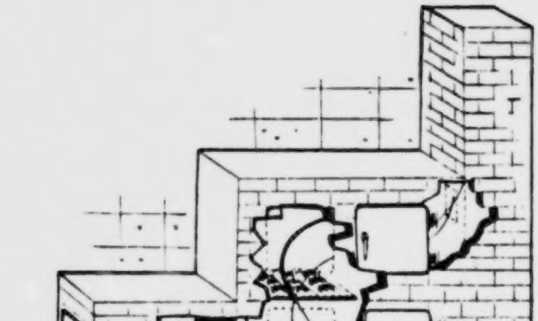
Barbecue pits are constructed above or below ground and are designed to roast an entire animal, as shown in Figure 4. The cooking surface consists of a flat wire mesh supported by pipes resting on upright hardwood planks.



PIT



SPIT



OVEN

Figure 4. Three methods of barbecuing.

These planks are also used for the sides of the pit. One end is usually stationary and the other movable so that different size pieces of meat can be accommodated. Sheet metal lines the lower inside surfaces and also provides a cover for the pit. This cover is removed only when turning the meat. The barbecuing agent is usually hickory wood, although oak, cherry, apple, pecan or orange wood produce satisfactory results.

A fire located close to the pit is allowed to burn until a white, ashen coal is produced. Coals are then placed in the bottom of the pit. The fire is maintained to supply a constant grill temperature of 93.3°C (200°F) during the entire cooking period, which may last several hours.

VENTILATION REQUIREMENTS

Direct meat-firing facilities are required to meet the various building and fire protection codes applicable in the specific locale. All cooking operations are required to have proper ventilating hoods, exhaust ducts and grease extractors although no specific removals efficiency is required. The exact legal requirements depend upon local regulations but usually involve the Building Officials and Code Administration (BOCA) Basic Mechanical Code[16] and the National Fire Protection Agency (NFPA) Code 96.[17] Pertinent sections of these codes are presented below.

SECTION M-321.0 COMMERCIAL HOODS AND FANS[16]

M-321.1 Required Locations: Commercial cooking appliances, such as restaurant-type ranges, deep fat fryers, broilers, roasting ovens, candy kettles, cruller furnaces and other commercial and industrial appliances that present a fire hazard similar to commercial frying operations, shall be provided with ventilating hoods and exhaust ducts. Range hoods and fans shall conform to the requirement of this section. Domestic ranges used for commercial purposes shall meet the requirements of this section.

M-321.3.4 Exhaust systems shall be provided with grease filters or grease retention elements conforming to Sections M-324,3.1 to M-324.3.5.

M-321.3.5 Grease filters or other means of grease extraction shall be of noncombustible construction designed for the specific purpose. The height of lowest edge of grease filters located above the cooking surface shall not be less than the following:

1. without exposed flame (grills, french-fryers, etc.). 2½ feet
2. exposed charcoal and charcoal-type fires........... 4 feet
3. exposed fires other than Item 2.................... 3½ feet

M-321.9 Ventilation for restaurant cooking equipment

M-321.9.1 Duct systems shall be designed to create a conveying air velocity in the exhaust ducts of not less than fifteen hundred (1500) feet per minute (fpm) and not more than twenty-two hundred (2200) feet per minute (fpm).

M-321.9.2 The design of the hood shall be such as to adequately collect and exhaust air, fumes, smoke and vapor from the area in which the hood is installed. Such hoods shall be equipped with mechanical exhaust blowers which exhaust a minimum of one hundred (100) cfm per square foot of hood area when the hood is attached to a wall. When the hood is located where all four (4) sides are exposed (center of room installations), a minimum of one hundred fifty (150) cfm of air per square foot of hood area shall be exhausted. Sufficient outside air shall be provided so that blowers in the kitchen area are adequately ventilated. Such air shall be approximately the same temperature as the air in the building or structure. Minimum overhang shall be three (3) inches per foot of height from the top of the appliance, and the total shall not be less than six (6) inches.

M-321.9.3. Low sidewall range-hoods, where the intake is within three (3) feet of the cooking surface, shall have a minimum volume of three hundred (300) cfm per lineal foot of cooking surface. The maximum setback from the face of the hood to edge of cooking equipment shall be one (1) foot.

M-321.9.4 Air velocity shall be uniform over the entire face of the hood.

NFPA-96[17]

4-1 Grease Removal Devices. Grease removal devices shall be provided and shall consist of one of the following types:

4-1.1 Listed Grease Extractors. Listed grease extractors shall be installed in accordance with the terms of the listing and the manufacturer's instructions.

4-1.2 Listed Grease Filters or Other Grease Removal Devices (Not Including Grease Extractors). Listed grease filters or other listed means of grease removal shall comply with the following requirements.

4-1.2.1 Materials

4-1.2.1.1 Grease filters, including frames, or other grease removal devices shall be constructed of noncombustible materials.

2-1.2.1.2 Grease filters shall be a type listed for use with commercial cooking equipment.

4-1.2.2 Installation

4-1.2.2.1 The distance between the grease filter or other grease removal device and the cooking surface shall be as great as possible. Where grease filters or other grease removal devices are used in conjunction with charcoal or charcoal-type broilers, including gas or electrically heated char-broilers, a minimum vertical distance of 4 feet shall be maintained between the lower edge of the grease filter or removal device and the cooking surface.

4-1.2.2.2 Grease filters or other grease removal devices shall be protected from combustion gas outlets and from direct flame impingement occurring during normal operation of cooking appliances

> producing high flue gas temperatures such as deep fat fryers, upright or high broiler (salamander broilers) when the distance between the filter or removal device and the appliance outlet (heat source) is less than 18 inches. This protection may be accomplished by the installation of a steel or stainless steel baffle plate between the heat source and the filter or removal device. The baffle plate shall be so sized and located that flames or combustion gases must travel a distance not less than 18 inches from the heat source to the grease filter or removal device. The baffle shall be located not less than 6 inches from filters or removal devices.

Based on these codes, the exhaust flow rates for a typical charbroiler are approximately 42.5 to 56.6 m^3/min (1,500 to 2,000 acfm). Flow rates from most present day kitchens may be appreciably higher since several other cooking operations besides the direct meat firing equipment are also vented through the same exhaust system. The additional pieces of equipment may increase the flow rate by a factor of 2 or 3. The average exhaust temperature from a direct meat firing operation is approximately 37.8°C (100°F); however, temperatures exceeding 54.4°C (130°F) have been reported.[18]

PARAMETERS INFLUENCING EMISSION RATES

The direct meat-firing industry is typical of any restaurant which operates during the day to meet the demands of the public. Unlike most industrial sources which try to operate at or near maximum capacity for as long as possible, the restaurant industry only reaches its peak during lunch time, 12 noon to 2:00 p.m. and dinner time, 6:00 to 8:00 p.m. During these periods of the day the grill is heavily used, resulting in maximum emission rates. The "slack" period between these peak periods is characterized by a decrease in use of the grill and results in a decrease in emissions. Therefore, emissions from a direct meat firing facility are related to the time of day as well as the number of customers.

Figure 5 shows how particulate emissions typically vary with the time of day and with the customer rate.[5] A heavy lunch period is shown to generate almost three times the particulate emissions of a moderate dinner period. Lunch periods are typically busier than dinner at the fast food chains and other restaurants which use direct meat firing, accounting for the higher reported emission rate.

The day of the week will affect emission rates at a direct meat-firing facility. The daily distribution of restaurant sales as reported by the National Restaurant Association[19] is as follows: Monday 10 percent, Tuesday 11 percent, Wednesday 12 percent, Thursday 12 percent, Friday 19 percent, Saturday 21 percent, and Sunday 16 percent. Assuming that emissions increase proportionally to dollar sales, emission rates will be higher during Friday, Saturday, and Sunday.

The season of the year also influences emission rates at a direct meat-firing facility. In most parts of the country, the number of customers decreases during winter months. Certain regions, however, will experience just

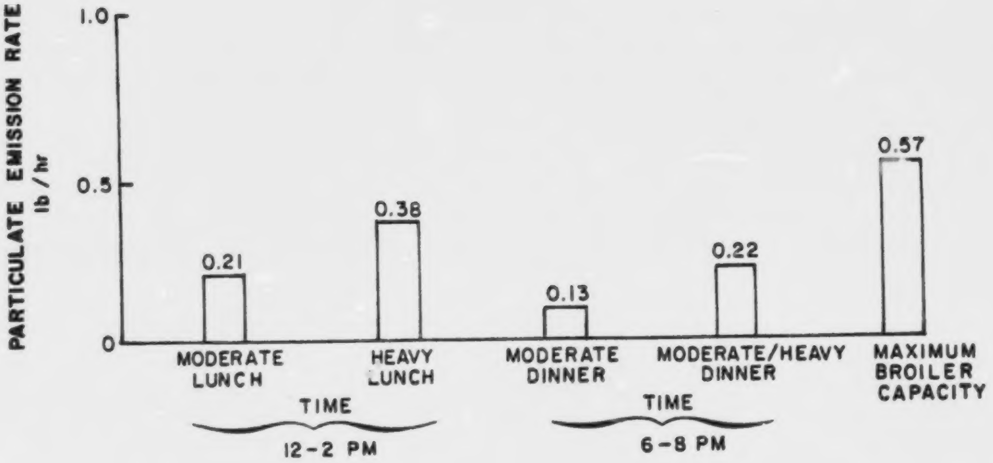


Figure 5. Variation in particulate emissions from a pilot plant direct meat-firing facility with time of day and with customer rate.[5]

the opposite effect during the winter. At ski resort areas and winter vacation areas, emissions from restaurants will generally increase during the busy winter months.

The type of meat cooked on a charbroiler or a barbecue will affect the type and rate of emissions.[6-10] The amount of grease and smoke from the grill increases, while cooking hamburgers, compared to cooking steaks. This is due to the higher content of fat in hamburger and to the texture of meat resulting from it being ground. The time of day and type of restaurant usually determines what type of meat is cooked. For example, fast food restaurants usually prepare hamburgers during the entire day. Full-service restaurants typically cook hamburgers for lunch and primarily steak for dinner. When changing from one type of meat to another, emissions from a direct meat-firing facility will vary accordingly.

The temperature at which a charbroiler is operated will also affect the rate of emissions. Most units are capabile of operating between 148.9°C and 371.1°C (300°F and 700°F), but are usually maintained at or near 204.4°C (400°F). During peak rush periods the restaurant manager may increase grill temperature above normal operating levels. Increasing the temperature will allow the chef to cook more meat per unit of time. This causes an increase in emissions due to the higher operating rate and to the increase in fat dripping onto the radiant surfaces.[20]

SECTION 3

EMISSIONS FROM DIRECT MEAT FIRING

EMISSION RATES

Emissions from direct meat firing consist primarily of particulates and organic vapors. Organic vapor is responsible for the characteristic odor and is attributable to alcohols, aldehydes, organic acids, nitrogen and sulfur compounds.[20] These compounds are decomposition products of fat, meat tenderizer and other meat additives. Particulates are extremely small; over 92.5 percent of the particulate matter is less than 1 micron (3.94×10^{-5} inches) in diameter. Figure 6 presents the results of a particle size analysis for a charbroiling operation.[12] The small particle size is typical of smoke produced by condensation of vapors.

The fat or grease present in meat consists mostly of a mixture of triglycerides.[20] Part of the triglyceride will hydrolyze to monoglycerides, diglycerides, aldehydes, alcohols and organic acids, depending on moisture content and grill operating temperature. Particulate and gaseous organic emissions are primarily generated as fat and grease spill on the hot grill or heat source.

A limited number of tests have been performed to determine emission rates from direct meat-firing facilities. Uncontrolled particulate and gaseous organic emissions were measured from a wood-fired barbecue.[21] Results of this compliance test indicate that particulate and gaseous organic emissions are 0.11 kg/hr (0.25 lb/hr) and 0.34 kg/hr (0.75 lb/hr), respectively. Uncontrolled particulate emissions have also been reported for a charcoal fired charbroiler.[18] The restaurant was tested during lunch (hamburger), afternoon (slack period), and supper (steak). As expected, the lunch-hamburger period showed highest emission rates at 0.38 kg/hr (0.84 lb/hr). The average of three tests, which were performed using EPA Method 5, showed an emission rate of 0.22 kg (0.48 lb) of particulates per hour.

Information on emissions from gas-fired charbroilers is more plentiful. Hardee's Food Systems Company has performed several tests on their gas-fired, charbroilers.[5,12,13] These tests included analysis for aldehydes, total gaseous organics (excluding aldehydes), NO_x, SO_2 and particulates EPA Method 5. Results of these tests plus those mentioned previously are presented in Table 3. These results are assumed to be representative and average of the size of restaurants found in the direct meat firing industry and are used in Model IV calculations.

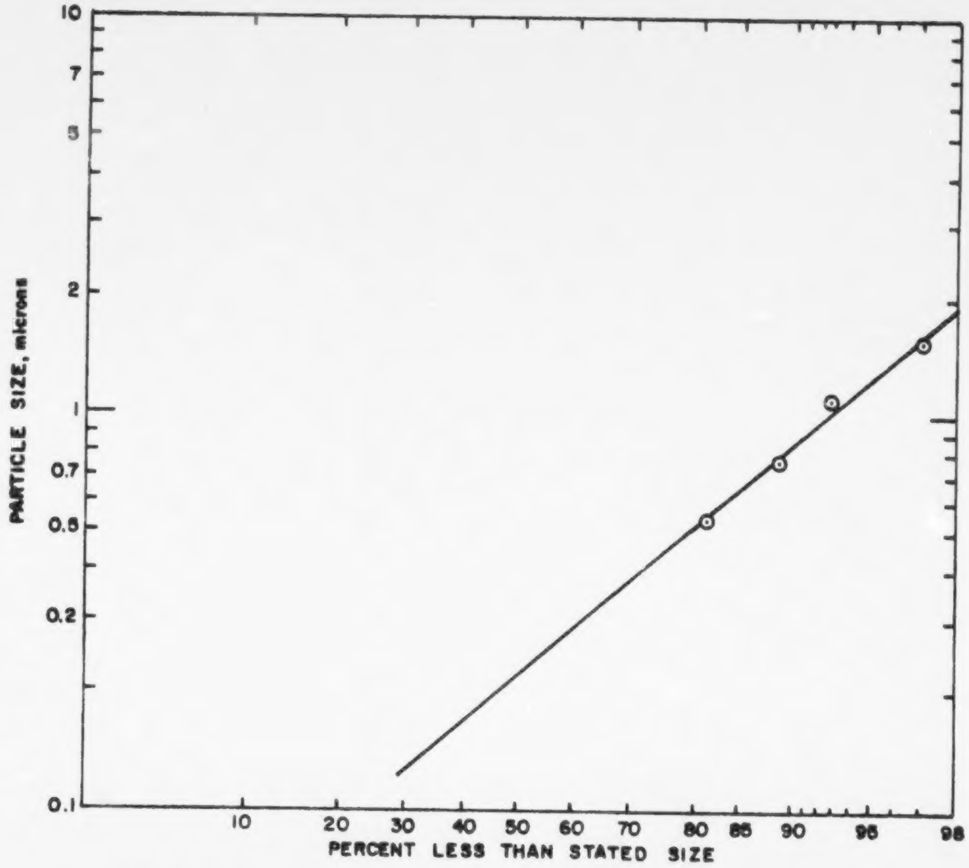


Figure 6. Particle size analysis charbroiler[12]

TABLE 3. EMISSION RATES FOR UNCONTROLLED DIRECT MEAT-FIRING FACILITIES

	Barbecue		Charbroilers					
			Charcoal/wood		Gas		Electric[*]	
Number of units base year 1977	500		300		27,400		3800	
	Range	Average	Range	Average	Range	Average	Range	Average
Particulate, lb/hr	0.23-0.28	0.25[†]	0.23-0.84	0.48[†]	3.92-6.08	5.2[‡,§]	3.92-6.08	5.2[‡]
Gaseous organics, lb/hr	0.55-1.0	0.75[†]		1.44				
Aldehydes, lb/hr					0.81-1.94	1.49[‡]	0.81-1.94	1.49[‡]
Total gaseous organics except aldehydes, lb/hr					0.06-0.23	0.14[‡]	0.06-0.23	0.14[‡]
NO_x, lb/hr					0.07-0.15	0.1	0.07-0.15	0.1
SO_2, lb/hr					< 0.024		< 0.024	

[*] Electric-fired factors assumed to be similar to gas-fired.

[†] Tests run at normal grill use rates, not maximum capacity.

[‡] Tests run at maximum capacity, to adjust to normal capacity multiply by K factor = 0.14.

[§] Particulate emission rate adjusted to account for a typical 60 percent efficient grease extractor. Tests were originally performed using an atypical (95 percent efficient) grease extractor.

To use emission test results performed by Hardee's in an appropriate manner, the following two items must be considered. All tests were performed under saturated conditions (full grill), and a highly efficient grease extractor (95 percent) preceded the sampling location. The grill was purposely kept full of hamburger patties throughout the entire test, a practice not customarily used by restaurant owners. Since the tests were run during abnormal load conditions it is necessary to adjust the saturated condition to an average condition. This can be accomplished by multiplying the emission rates for gas- and electric-fired units in Table 3 by a K factor - the normal fractional utilization rate of existing capacity. Derivation of this K factor (0.14) can be found in Section 6.

The Hardee's tests also used a high efficiency grease extractor, Gaylord "Model AB," which is 95 percent efficient in the removal of particulate matter.[11,22] This particular extractor is far more efficient than those presently used by most existing restaurants. Grease extractors are generally required on all cooking operations, and the more common extractor, the baffle type or screen mesh type, is approximately 60 percent efficient.[23,24] To account for this difference in efficiency the particulate emission rates for gas-fired charbroilers presented in Table 3 have been adjusted to represent an average or typical restaurant operation.

Emissions from an electrically-fired charbroiler are assumed to be similar to a gas-fired charbroiler because the operation of both systems is very similar.[11] This assumption is necessary because of the lack of test data for electrically-fired charbroilers.

A gaseous organic emission rate for charcoal/wood-fired charbroilers has been estimated by GCA due to the lack of test data. The ratio of gaseous organic materials to particulate matter for charcoal/wood-fired charbroilers is assumed equivalent to a barbecue because of the similarity of fuels. On this basis the uncontrolled emission rate is 0.65 kg/hr (1.44 lb/hr).

ANNUAL EMISSION ESTIMATES

Estimates of annual emissions for the direct meat-firing industry are presented in Table 4. These emission estimates are based on emission rates developed from source tests (shown in Table 3) and a 0.14 K factor for gas- and electrically-fired charbroilers and a 1.0 K factor for barbecues and charcoal/wood-fired charbroilers. The normal operating schedule for a direct meat-firing facility is assumed to be 12 hours per day, 365 days per year, or 4,380 hours per year.

Particulate emissions from all direct meat-firing facilities are 45.7×10^6 kg (50,350 tons) per year or approximately 1,360 kg (1.5 tons) per facility per year. Gaseous organic emissions total 15.8×10^6 kg (17,370 tons) per year or approximately 454 kg (0.5 tons) per facility per year. Emissions of NO_x and SO_2 are negligible, estimated at 27.2 kg/yr and 6.8 kg/yr (60 lb/yr and 15 lb/yr), respectively, for each facility.

TABLE 4. ANNUAL EMISSIONS FROM THE DIRECT MEAT-FIRING INDUSTRY, BASE YEAR 1977

	Barbecue	Charbroilers			Totals
		Charcoal/wood	Gas	Electric	
Number of units	500	300	27,400	3,800	32,000
Particulates, tons/yr	270	320	43,700	6,060	50,350
Total volatile organics, tons/yr	820	950	13,700	1,900	17,370
NO_x			negligible 60 lb/facility-yr	negligible 60 lb/facility-yr	
SO_x			negligible 15 lb/facility-yr	negligible 15 lb/facility-yr	

EMISSION OF CARCINOGENIC COMPOUNDS

During the incomplete combustion of organic matter in a charbroiler, numerous organic compounds are formed. Several of these compounds have been found to be carcinogenic to animals. Tests conducted by Langston Labs[25] have shown that during the incomplete combustion at a charcoal burning restaurant, polycyclic organic matter (POM) and polychlorinated biphenyls (PCB) were detected in the stack gases. The POM compounds consisted of anthracene, pyrene, benzo(a) anthracene (BAA), benzo(a)pyrene (BAP) and coronene. The PCBs detected were similar to Arochlor 1242.

Concentrations of POM ranged from 180.7 to 1190.0 nanograms/m^3 (0.01 to 0.07×10^{-9} lb/ft^3) while concentrations of PCB ranged from 802.2 to 9489.3 nanograms/m^3 (0.05 to 0.6×10^{-9} lb/ft^3). The presence of potential carcinogens in the exhaust from charbroilers should receive further investigation.

SECTION 4

APPLICABLE BEST SYSTEMS OF EMISSION REDUCTION

CONTROL OF PARTICULATE EMISSIONS

Two systems are commercially available to control particulate emissions from direct meat-firing facilities. They are: a mist eliminator system marketed by Hardee's Food Systems[26] under the trade name "Conqueror" and electrostatic precipitators. Several other systems in the design or pilot plant stage of operation have not been sufficiently tested on direct meat-firing facilities to obtain efficiency ratings. These systems will be discussed at the end of this section. Afterburners were considered as possible control devices for particulates. However, afterburners are not considered best available control technology because of the lack of data to substantiate their effectiveness, the high temperatures needed for complete combustion (760°C) (1400°F)[27] and because of the availability of two other less costly systems. High consumption of natural gas plus uncertainties of obtaining this fuel make afterburners a costly and unreliable system to operate. Fuel bills of several thousand dollars per month would not be uncommon for operating an afterburner on direct meat-firing units.

Hardee's Conqueror

Hardee's Food System, Incorporated has recently developed and successfully tested a mist eliminator system capable of removing 93 percent[28] by weight of the particulates from a direct meat-firing facility. Several of the units are now in operation throughout the country.

Hardee's system, shown in Figure 7, is composed of a Monsanto Brink® mist eliminator mounted inside a tank housing, and a Gaylord type "AB" grease extractor.[11] Air flows from the Gaylord grease extractor into the transition section of the mist eliminator. A small amount of water sprayed into the transition section evaporates and cools the gas stream. The air then passes through the cylindrical glass fiber packed Brink® mist eliminator and is exhausted through the annular space between the fiber element and the tank housing to the atmosphere. A 5 horsepower fan draws gases through the system.

The Monsanto Brink® element consists of a bed of synthetic fibers held between concentric cylindrical screens. The fiber pad mist eliminator element has been developed to remove submicron size liquid mist particles and water soluble solids. The manufacturer claims that the fiber element can be designed to provide collection efficiencies up to 99.95 percent on all particles 3 microns (11.8×10^{-5} inches) and smaller in diameter.[29]

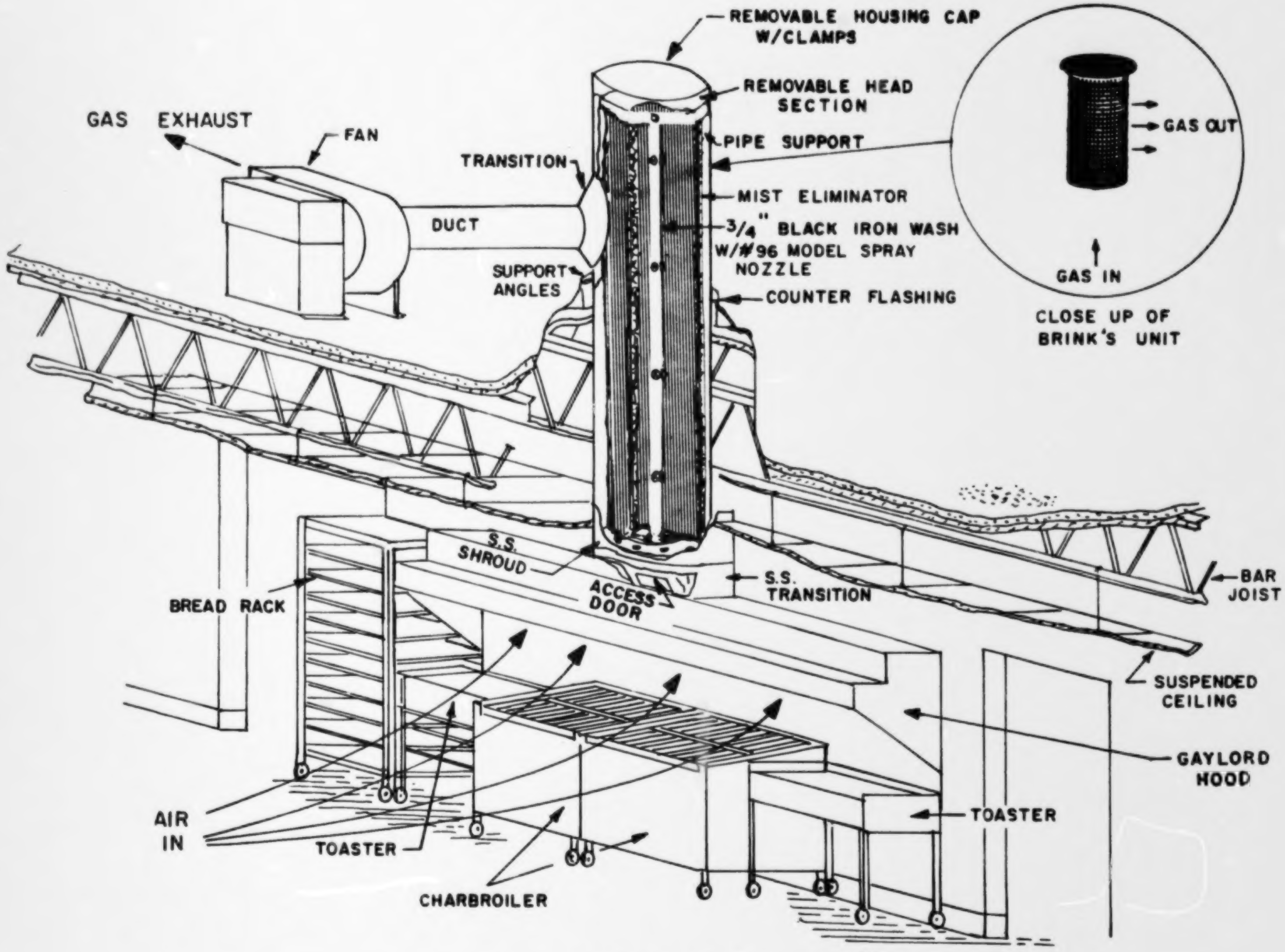

REMOVABLE HOUSING CAP W/CLAMPS
REMOVABLE HEAD SECTION
PIPE SUPPORT
MIST ELIMINATOR
3/4" BLACK IRON WASH W/#96 MODEL SPRAY NOZZLE
COUNTER FLASHING
GAS OUT
GAS IN
CLOSE UP OF BRINK'S UNIT
GAS EXHAUST
FAN
TRANSITION
DUCT
SUPPORT ANGLES
S.S. SHROUD
ACCESS DOOR
S.S. TRANSITION
BAR JOIST
SUSPENDED CEILING
GAYLORD HOOD
BREAD RACK
AIR IN
TOASTER
CHARBROILER
TOASTER

Figure 7. Hardee's Conqueror.[29]

Particles larger than 3 microns are removed by inertial impaction while particles less than 3 microns are captured by direct interception and Brownian movement. Brownian movement, or diffusion, is defined as random back and forth movement of fine particles caused by collisions with gas molecules.

The "Conqueror" control device is presently available in two lengths: 2.4 m and 3.0 m (8 and 10 feet). Each section is 0.6 m (2 feet) in diameter. The smaller unit controls emissions for a flow rate up to 70.8 m^3/min (2500 acfm) and the larger unit can handle a flow rate up to 84.9 m^3/min (3000 acfm).

For use on direct meat-firing facilities, the "Conqueror" is designed to work in conjunction with a Gaylord "Model AB" grease extractor. This grease extractor uses a baffle type filtering system with an automatic water wash. The grease extractor itself is 95 percent efficient[31] on removal of particulates and grease. Grease extractors are considered an integral part of the process and are not by themselves considered air pollution control devices.

During normal operation of the "Conqueror," a small amount of water is sprayed into the gas stream prior to entering the filter pad. This water is completely evaporated as it cools incoming gases. According to the manufacturer, a small dosage of detergent added to this water spray will noticeably decrease odor from the exhaust stack.

After a normal business day, the "Conqueror" cleaning system is activated. This initiates a wash cycle where caustic detergent solution is sprayed directly onto the inside of the mist eliminator's fiber pad. After the wash period, a soak period takes place. At the end of the soak cycle, the system is rinsed with cold water. The application of hot water has caused some scale formation in past models, but this problem has reportedly been solved in the newer models.[11] All waste water from the "Conqueror" is passed through the Gaylord grease extractor prior to entering the drain. Before the start of the next business day, the Gaylord grease extractor is cleaned with hot water and detergent. The fan is then turned on to dry the system. The pressure drop across the filter element when wet is approximately 20.3 to 22.9 cm (8 to 9 inches) of water. However, as the element dries, the pressure drop reaches its normal 12.7 to 15.2 cm (5 to 6 inches) of water. It will remain in this range until grease and char start to plug the filter element causing a slight increase in pressure drop. An increase in pressure drop will not adversely affect the system and, in fact, indicates an increase in collection efficiency.

Typical cost for a 84.9 m^3/min (3000 acfm) "Conqueror" is approximately $6,000, and cost for a Gaylord grease extractor is approximately $4,800. Total uninstalled cost for the complete system is, therefore, approximately $11,000. Based on information provided by the manufacturer, the cost of operating the control device is expected to be $140 per month. This figure includes costs for hot water, caustic detergent and electricity.

There should be no major adverse environmental impact associated with operation of the "Conqueror" control device. The amount of liquid wastes generated during the daily cleaning cycle is presented in Table 5. The waste water, which contains a small amount of caustic detergent and grease cleaned from the filter and the grease extractor, should present no problems to wastewater treatment plants. The quantity of material is small and is biodegradable.

TABLE 5. LIQUID WASTES PER WASH FROM "CONQUEROR SYSTEM" PER 24 HOURS/DAY

	"Conqueror"*	Gaylord grease extractor "Model AB"
Detergent	66 ounces	54 ounces
Water†	Hot wash 40.8 gallons Cold rinse 65.4 gallons	Hot wash 57 gallons

*24 in. × 120 in. filter element.

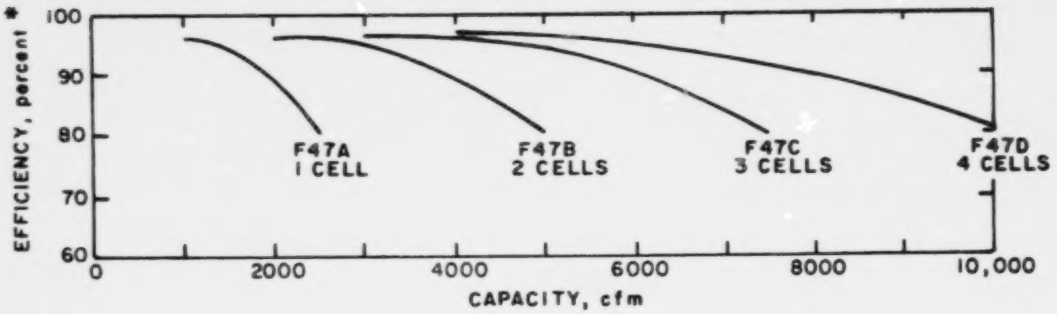
†60 pounds per square inch water pressure, 180°F.

Electrostatic Precipitators

Electrostatic precipitators (ESP) designed by several air pollution control companies for use in restaurants have been successfully used to remove fine particulates from direct meat-firing facilities.[30-33] If properly designed and maintained, ESP's have been shown to be 90 percent efficient for particles as small as 0.03 microns (0.12×10^{-5} inches).[30] Flow rate through an ESP will affect collection efficiency. Most restaurant units are normally designed in modules of 56.6 m^3/min (2000 acfm) capacity each. By placing several units in series, or parallel the proper combination of flow rate and efficiency can be achieved. Figure 8 shows the correlation between efficiency, flow rate and number of cells for a typical ESP installation.[32] As indicated in this figure, efficiencies vary from a low of 80 percent to a high of 96 percent. Because blinding of collection cells normally occurs during daily use, efficiency of the unit will decrease with time.[20] For this reason, an average efficiency of 90 percent is considered typical of an ESP control device.[34]

The two stage electrostatic precipitation process (see Figure 9) involves placing an electric charge on liquid or solid particles present in the gas stream by bombardment with gaseous ions or electrons produced by a high voltage source. Charged particles are neutralized and captured by the collecting electrode or plate of opposite polarity. Collected material is then washed off the plate with water and detergent.

Because efficiency of the unit depends on cleanliness of the collecting electrode (plates), several manufacturers have incorporated a self-cleaning mechanism into the ESP. Instead of requiring removing all the collecting cells for manual washing, these units rely on internal spray nozzles for cleaning. Timers are used in conjunction with the cleaning system to regulate wash and rinse cycles. The unit cannot be cleaned while in daily service,



*EFFICIENCY RATINGS BASED ON NATIONAL BUREAU OF STANDARDS DUST SPOT METHOD AND AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR CONDITIONING ENGINEERS STANDARDS 52-68, USING ATMOSPHERIC DUST.

Figure 8. Electronic air cleaner capacity and efficiency.[32]

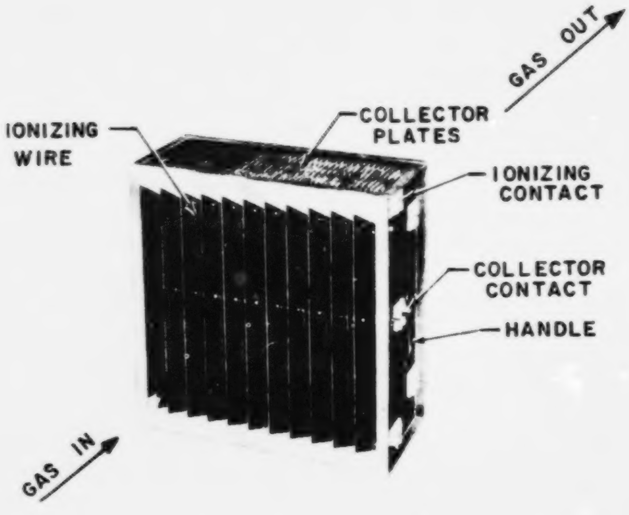

GAS OUT
IONIZING WIRE
COLLECTOR PLATES
IONIZING CONTACT
COLLECTOR CONTACT
HANDLE
GAS IN

Figure 9. Electrostatic precipitator cell.[32]

and is washed at the end of the business day. It is recommended that cells be cleaned regularly, so collection efficiency will remain high.

The operating voltage for the ESP ionizer is typically 10,000 to 13,000 volts, and current ranges from 4 to 8 milliamperes. Collector plates operate at essentially 0 current at about 6000 volts.[20,32] Gas flow rates through the collector are typically 0.25 to 0.36 meters per second (50 to 70 feet per minute).

Factors affecting efficiency of an ESP are:

- Frequency of cleaning collector plates
- Available area of collector plates
- Distance between collector plates
- Particle Size
- Operating voltages
- Gas velocity
- Distribution profile of gas through the ionizer and collector plates

These factors are normally taken into account during the design of an ESP. However, applied voltage, gas velocity and distribution can change during normal usage. The accumulation of char material on collector plates will greatly alter performance characteristics and will result in a reduction in efficiency. To compensate for this loss of efficiency, adequate cleaning practices must be employed.

The typical cost for a 84.9 m^3/min (3000 acfm) electrostatic precipitator is approximately $9,000, uninstalled. A 42.5 m^3/min (1500 acfm) unit will cost approximately $5,500.[31] If the automatic cleaning mechanism is desired an additional $1,500 to $2,000 will be required to cover the cost. The major operating expenses associated with an ESP are hot water and detergent. Hot water, depending on the make and model of ESP used, could range from $40 to $100 per month. Detergent will range from $30 to $50 per month. The cost of electricity to run the ESP is minimal, usually less than $10 per month.[20,31,33]

There should be no major adverse environmental impact associated with operation of an electrostatic precipitator. Wastewater effluent should be similar in nature to wastewater from a Hardee's "Conqueror," which consists mostly of water, detergent and grease rinsed from collector plates. The amount of liquid waste generated during a daily wash cycle will vary, depending on the specific ESP model used. The amount of hot water (60°C to 82.2°C) (140°F to 180°F) is reported to be as low as 132.5 ℓ (35 gallons) per wash[32] and as high as 567.8 ℓ (150 gallons) per wash.[31] Detergent usage similarly can vary from 14.8 or 17.7 mℓ (5 or 6 ounces) per wash to over 59 mℓ (20 ounces) per wash.

CONTROL OF GASEOUS ORGANIC MATERIALS

The second major pollutant emitted from direct meat-firing facilities is gaseous organic materials. Source test data presented in Section 3 indicates that approximately 454.5 kg (0.5 tons) of gaseous organic materials are emitted each year from a typical direct meat-firing facility. The only available method of effectively reducing these emissions is the afterburner. Unfortunately, gaseous organic emissions test data do not exist for a direct meat-firing facility, so the efficiency of these control units cannot be substantiated. However, the literature indicates that when afterburner temperatures are maintained at 760°C (1400°F), essentially complete combustion will occur.[27] Afterburners are presently used by some restaurants to control visible smoke.[35] The smoke plume can usually meet state opacity regulations by heating the effluent gases to 260°C to 426.6°C (500°F to 800°F). An afterburner operating at such a low temperature will succeed in only vaporizing the visible smoke and rendering it invisible.

A properly maintained afterburner will also control odor from a direct meat firing facility, since most odors are caused by aldehydes which are organic and combustible. For Model IV calculations, it is assumed that afterburners are technically feasible for controlling gaseous organic emissions and are 99 percent efficient.[27] A plot of temperature versus efficiency for a thermal afterburner is shown in Figure 10.

One major drawback associated with the afterburner is its cost of operation. Estimated total gas consumption of a system designed to control a 42.5 m^3/min (1500 acfm) air flow rate is approximately 0.35×10^6 m^3 (12.4×10^6 ft^3) per year. The cost of operating an afterburner for 12 hours per day, 365 days per year, assuming natural gas costs $2.50 per 28.3 m^3 (1000 ft^3), is approximately $2,600 per month. The capital cost of the unit is in the range of $6,000 to $8,000. The use of a thermal recovery unit in the exhaust stack may make this system more economically attractive.

In afterburners, as in any combustion equipment where fuel is burned in the presence of air, some reactions of nitrogen and oxygen will take place to form nitric oxide and nitrogen dioxide (NO_x). Most of the NO_x formed in the afterburner is generated in the high temperature region of the burner flame. Only a minor fraction is actually produced in the main residence-time section of the afterburner. Emission factors for gas-fired afterburners indicate that typically 22.7 to 45.4 gms (0.05 to 0.1 lb) of NO_x expressed as NO_2 are formed per 0.252×10^6 Kcal (10^6 Btu) of fuel burned.[27] If all direct meat firing facilities used afterburners, approximately 28.7×10^6 kg (31,600 tons) of NO_x emissions would be produced in 1988.

There are no solid or liquid wastes generated from an afterburner.

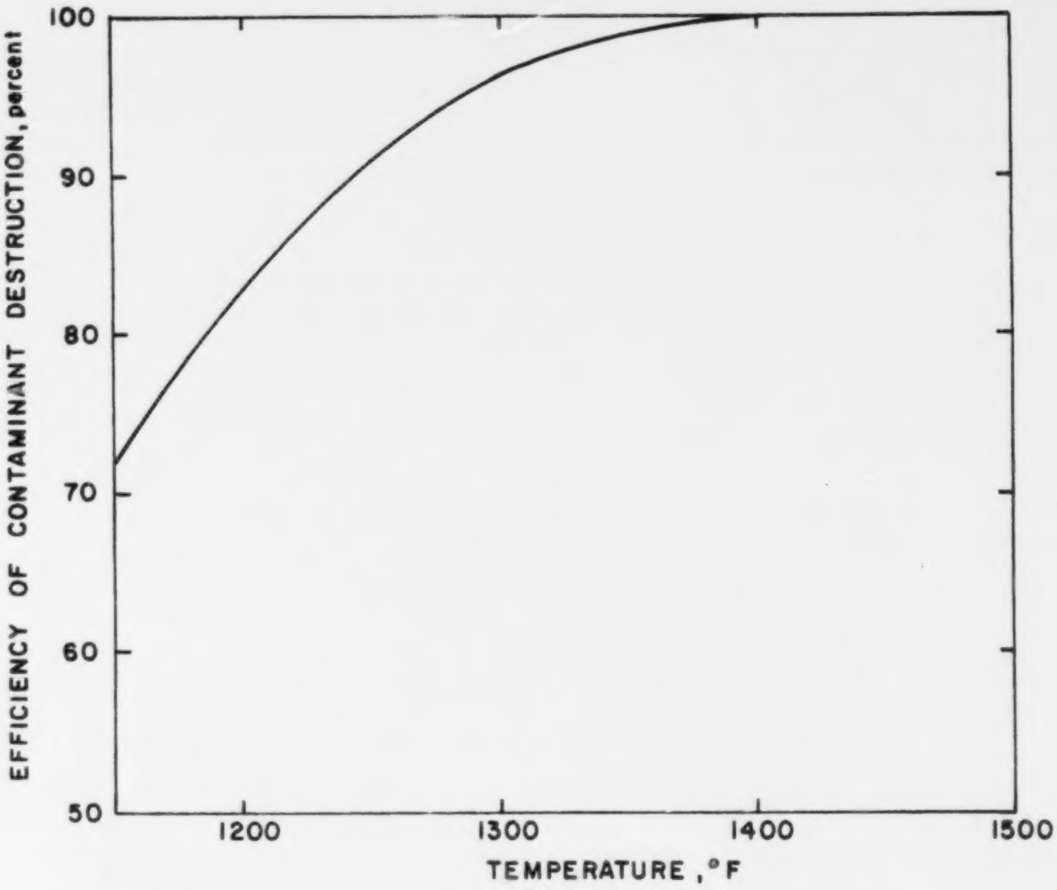


Figure 10. Typical effect of operating temperature on effectiveness of thermal afterburner for destruction of hydrocarbons.[27]

CONTROL SYSTEMS UNDER DEVELOPMENT

Twister-Aire Recycler

The following description is taken from literature supplied by Palm Brothers, manufacturer of the Twister-Aire Recycler.[36]

The Twister-Aire Recycler cooking ventilation system consists of a stainless steel hood which effectively removes particles by centrifugal acceleration in the Twister tubes. As the grease collects on these tubes it also acts as a media to capture dry particles, including lint and smoke. Periodically these tubes are time washed with hot water through the nozzle system with the waste running to drain connection. Grease collection is so effective that the ductwork from the hood remains grease free, greatly reducing the possibility of fire in the ductwork. The hood, although conventional in appearance, draws air very uniformly over its entire length because of its slot construction over the Twister tubes.

Ductwork leads to one or more three-stage purifying modules, each accommodating 42.5 m^3/min (1500 acfm). The first stage consists of a throw-away prefilter which accumulates any remaining grease fumes that may be in the airstream and also captures additional smoke particles. The second stage is an activated charcoal bank, designed for reactivation at the factory, which adsorbs the odor in the airstream. The final stage is a HEPA filter, the same as used in hospital clean rooms, which removes all remaining smoke particles plus bacteria and most virus (95 percent efficient on 0.3 micron particles). After the HEPA filter, the airstream is monitored by the 24-volt control circuit. This consists of sensors which signal the voltage control to maintain constant cfm as the static pressure increases across the filter media. It also has a temperature sensor which detects an increased temperature of the airstream in the event of a fire, sprays cold water through the nozzle system in the hood, and increases the blower to maximum cfm. A second temperature sensor shuts down the recycling system in the event the air temperatue reaches 51.6°C (125°F). A blower, which is the only moving part, draws the airstream through the system and then back into the building heating ventilating system. No make-up air is required since there is no exhaust to the outside.

No efficiency tests have been conducted for the Twister-Aire Recycler on direct meat-firing facilities. To conserve on building heating costs, this system exhausts to the building ventilation system and not the outside air. This violates the BOCA codes[16] which specifically states that all ducts shall lead as directly as possible to the outside and shall not be connected with any other exhaust system. Further testing and proper ducting of this system may prove it to be a viable control device in the future.

Airgiene Vapo-Reactor

The Airgiene Vapo-Reactor[37] is manufactured by the Drexel T. Carlson Company and is claimed capable of controlling particulates and fumes generated by charbroilers and barbecues.

The process involves impacting incoming gases with the surface of an aqueous solution located at the bottom of the vessel. This action results in humidification of the gas and retention of 80 percent of particulates greater than 20 microns (78.8×10^{-5} inches). Ambient air is then added to the humidified gas mixture and cools it below its dew point. A portion of the resulting vapor condenses and forms microscopic liquid droplets. The gas, which now contains ambient air, microscopic aerosols and impurities, is returned to the bottom of the vessel for a second impaction. The entire process is repeated two more times, and each succeeding pass removes particulate matter from the gas stream.

This system has never undergone a particulate stack test. The only measurements taken to date have been opacity readings, which have been below 10 percent. A test unit is presently being installed on the Hereford House Restaurant in Kansas City, Missouri.

Aero-Dyne

The Aero-Dyne Company[38] manufacturers a mini-afterburner control device and an efficient ventilation hood for restaurants. Aero-Dyne's ventilation hood greatly reduces the amount of air drawn into the control device. Decreasing the air flow rate reduces both capital equipment costs and operating costs of treating the exhaust stream. In some cases, an exhaust flow reduction as high as 70 percent has been achieved for the Aero-Dyne ventilation hood.[38] Figure 11 shows the design of the Aero-Dyne hood. Enclosing the cooking area on three sides and decreasing the height of the hood substantially decreases the required exhaust flow rate. The specially designed curved shape of the hood helps direct air flow, thus reducing impaction of grease on the sides of the unit.

The mini-afterburner sold with the hood and grease extractor is presently designed to operate at 260°C (500°F). This is sufficient to reduce opacity of exhaust gases, but is considerably below the 760°C (1400°F) required for complete combustion and elimination of gaseous organic matter.

ALTERNATIVE TO DIRECT MEAT FIRING

An alternative to direct meat firing, specifically charbroiling, has been developed and reduces emission levels while retaining the aesthetic features of direct fired meat. The grooved griddle manufactured by the Wolf Range Co.[39] and the Ember-Glo Company[40] is a 2.54 cm (1-inch) thick plate 6.1 cm (24 inches) in length, shown in Figure 12. The plate is a highly polished steel surface with milled grooves to provide markings similar to a charbroiled piece of meat. Meat is cooked by conductive heat on the top ridges and by radiant heat from the grooves of the plate. Because the surface temperature is normally lower than conventional open grills and because fat from the meat does not drop back onto the open flame, emissions are reported to be considerably less than from a charbroiler.[20] The manufacturers claim that the appearance, aroma, and flavor of the meat are similar to a charbroiling operation. This type of cooking operation is reportedly able to reduce emissions below state and local air pollution visible emission regulations,[20] and may be a viable alternative for new restaurants.

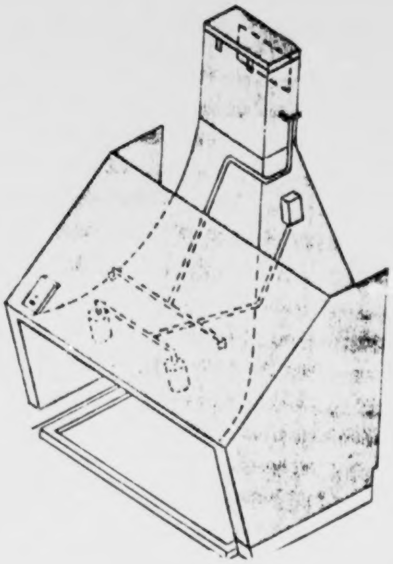


Figure 11. Aero-Dyne laminar flow exhaust hood.[38]

Figure 12. Grooved griddle.[40]

SECTION 5

STATE AIR POLLUTION CONTROL REGULATIONS APPLICABLE TO DIRECT MEAT-FIRING FACILITIES

Air pollution control regulations pertaining to emission of particulate matter (process weight regulations), visible emissions or opacity, and gaseous organic material emissions for each state are listed in Tables 6 through 13 and in Figures 13 and 14. GCA contacted several state and local air pollution control agencies to identify the extent to which regulations are enforced at direct meat-firing facilities. Based on this survey, only Washington, D.C. strictly enforces the process weight regulation on the direct meat-firing industry. Many states such as New York, provide exemption for these sources as emissions are considered minor. Many states have chosen to allocate available manpower to concentrate on larger emission sources. Usually, budgetary constraints of air pollution control agencies restrict the level of routine investigation on the direct meat-firing industry. As a result, two courses of action are prevalent with respect to state enforcement actions towards direct meat-firing facilities.

The state may initiate an investigation when a complaint is received, which is typically an odor complaint. In other situations the state refers enforcement responsibilities to district offices or to local agencies. After a complaint is received by an air pollution control agency, the process weight regulation is rarely enforced. Visible emission and odor regulations are typically employed for enforcement action.

In most cases the local agencies have adopted the respective state regulations. Enforcement action by local agencies is generally similar to state agencies; i.e., response to public complaints. A few agencies, primarily those serving areas lacking large emission sources, have identified emissions from direct meat-firing sources as major sources and attempt to routinely enforce visible emission regulations. These agencies are typically located in areas where tourism is the prime industry. Included here are mountain resorts (i.e., Colorado); areas of the midwest where charbroiling is popular (i.e., Missouri) and areas where barbecues are popular (i.e., Jacksonville, Florida).

Since only one agency is known to strictly enforce a process weight regulation (Washington, D.C.), GCA assumed that particulate emissions from direct meat-firing facilities are uncontrolled.

Very few states currently have standards for the regulation of organic discharges. Uncontrolled gaseous organic emissions from direct meat firing are generally quite low, as shown in Table 4, and are less than allowed by existing regulations. Calculations for Model IV gaseous organic emissions are based on the uncontrolled emission rates developed previously in Section 3.

TABLE 6. STATE PARTICULATE PROCESS WEIGHT REGULATIONS APPLICABLE TO THE DIRECT MEAT-FIRING INDUSTRY

State	Regulation
Alabama	A for Class 1 counties B for Class 2 counties
Alaska	0.05 grain/scf 0.1 grain/scf if in use prior to 7/1/72
Arizona	A for Phoenix-Tucscon AQCR B for remainder of state
Arkansas	A
California	None
Colorado	A
Connecticut	A
Delaware	0.2 grains/scf
District of Columbia	0.03 grains/scf (see Table 8)
Florida	A
Georgia	B
Hawaii	B except $\geq$ 60,000 lbs/hr allowable is 40 lbs/hr
Idaho	B
Illinois	B existing sources C new sources
Indiana	B
Iowa	B
Kansas	B
Kentucky	A
Louisiana	B
Maine	A
Maryland	0.03 grains/scf Baltimore and Washington AQCR Table 8 remainder of state
Massachusetts	See Table 8
Michigan	B
Minnesota	A
Mississippi	See Table 9
Missouri	B
Montana	B
Nebraska	B
Nevada	B
New Hampshire	B
New Jersey	See Table 10
New Maxico	None
New York	None
North Carolina	B
North Dakota	B

(continued)

TABLE 6 (continued)

State	Regulation
Ohio	B
Oklahoma	B
Oregon	See Table 8
Pennsylvania	See Figure 14
Rhode Island	B
South Carolina	B
South Dakota	B
Tennessee	B existing A new
Texas	D
Utah	85 percent control for 100 ton/yr sources
Vermont	See Table 8
Virginia	Table 8 for National Capital AQCR B remainder of state
Washington	None
West Virginia	See Table 11
Wisconsin	A
Wyoming	A

Legend

Key	Process weight equations
A	$\begin{cases} E = 3.59\,p^{0.62} & p \le 30 \text{ tons/hr} \\ E = 17.31\,p^{0.16} & p > 30 \text{ tons/hr} \end{cases}$
B	$\begin{cases} E = 4.1\,p^{0.67} & p \le 30 \text{ tons/hr} \\ E = 55.0\,p^{0.11}-40 & p > 30 \text{ tons/hr} \end{cases}$
C	$\begin{cases} E = 2.54\,p^{0.534} & p \le 450 \text{ tons/hr} \\ E = 24.8\,p^{0.16} & p > 450 \text{ tons/hr} \end{cases}$
D	$\begin{cases} E = 3.12\,p^{0.985} & p \le 20 \text{ tons/hr} \\ E = 25.4\,p^{0.287} & p > 20 \text{ tons/hr} \end{cases}$

where E = Emission rate in pounds per hour.
p = Process weight in tons per hour.

TABLE 7. TABULATION OF PROCESS WEIGHT EQUATIONS USED IN TABLE 6

Process weight rate		Rate of particulate emissions (lb/hr) process weight equations			
lbs/hr	tons/hr	A	B	C	D
100	0.05	0.56	0.55	0.51	0.16
200	0.10	0.86	0.88	0.74	0.32
400	0.20	1.32	1.40	1.08	0.64
1,000	0.50	2.34	2.58	1.75	1.6
2,000	1.00	3.99	4.10	2.54	3.1
3,000	1.50	4.62	5.38	3.15	4.7
4,000	2.00	5.52	6.52	3.68	6.2
5,000	2.50	6.34	7.58	4.14	7.7
6,000	3.00	7.09	8.56	4.57	9.2
7,000	3.50	7.81	9.49	4.96	10.7
8,000	4.00	8.5	10.4	5.3	12.2
9,000	4.50	9.1	11.2	5.7	13.7
10,000	5.00	9.7	12.0	6.0	15.2
12,000	6.00	10.9	13.6	6.6	18.2
16,000	8.00	13.0	16.5	7.7	24.2
18,000	9.00	14.0	17.9	8.2	27.2
20,000	10.00	15.0	19.2	8.7	30.1
30,000	15.00	19.2	25.2	10.8	44.9
40,000	20.00	23.0	30.5	12.6	59.7
50,000	25.00	26.4	35.4	14.2	64.0
60,000	30.00	29.6	40.0	15.6	67.4
70,000	35.00	30.6	41.3	17.0	70.5
80,000	40.00	31.2	42.5	18.2	73.2
90,000	45.00	31.8	43.6	19.4	75.7
100,000	50.00	32.4	44.6	20.5	78.1
120,000	60.00	33.3	46.3	22.6	82.3
140,000	70.00	39.2	47.8	24.6	86.0
160,000	80.00	34.9	49.0	26.9	89.3
200,000	100.00	36.2	51.2	29.7	95.2
1,000,000	500.00	46.8	69.0	67.0	151.2
2,000,000	1,000.00	52.3	77.6	74.9	184.4
6,000,000	3,000.00	62.3	92.7	89.3	252.8
20,000,000	10,000.00	75.6	111.5	108.3	357.1

TABLE 8. PROCESS WEIGHT REGULATION FOR VERMONT, MARYLAND, OREGON, MASSACHUSETTS, AND THE DISTRICT OF COLUMBIA METROPOLITAN AREA

Process weight (lbs/hr)	Discharge maximum weight (lbs/hr)	Process weight (lbs/hr)	Discharge maximum weight (lbs/hr)
50	0.24	3,400	5.44
100	0.46	3,500	5.52
150	0.66	3,600	5.61
200	0.85	3,700	5.69
250	1.03	3,800	5.77
300	1.20	3,900	5.85
350	1.35	4,000	5.93
400	1.50	4,100	6.01
450	1.63	4,200	6.08
500	1.77	4,300	6.15
550	1.89	4,400	6.22
600	2.01	4,500	6.30
650	2.12	4,600	6.37
700	2.24	4,700	6.45
750	2.34	4,800	6.52
800	2.43	4,900	6.60
850	2.53	5,000	6.67
900	2.62	5,500	7.03
950	2.72	6,000	7.37
1,000	2.80	6,500	7.71
1,100	2.97	7,000	8.05
1,200	3.12	7,500	8.39
1,300	3.26	8,000	8.71
1,400	3.40	8,500	9.03
1,500	3.54	9,000	9.36
1,600	3.66	9,500	9.67
1,700	3.79	10,000	10.0
1,800	3.91	11,000	10.63
1,900	4.03	12,000	11.28
2,000	4.14	13,000	11.89
2,100	4.24	14,000	12.50
2,200	4.34	15,000	13.13
2,300	4.44	16,000	13.74
2,400	4.55	17,000	14.36
2,500	4.64	18,000	14.97
2,600	4.74	19,000	15.58
2,700	4.84	20,000	16.19
2,800	4.92	30,000	22.22
2,900	5.02	40,000	28.3
3,000	5.10	50,000	34.3

TABLE 9. PROCESS WEIGHT REGULATION IN MISSISSIPPI

Process weight (lb/hr)	Input rate (tons/hr)	Rate of emission (lb/hr)	Process input weight rate lb/hr	Process input weight rate tons/hr	Rate of emission (lb/hr)
100	0.05	0.551	16,000	8	16.5
200	0.10	0.877	18,000	9	17.9
400	0.20	1.40	20,000	10	19.2
600	0.30	1.83	30,000	15	25.2
800	0.40	2.22	40,000	20	30.5
1,000	0.50	2.58	50,000	25	35.4
1,500	0.75	3.38	60,000	30	40.0
2,000	1.00	4.10	70,000	35	44.4
2,500	1.25	4.76	80,000	40	48.6
3,000	1.50	5.38	90,000	45	52.5
3,500	1.75	5.96	100,000	50	56.4
4,000	2.00	6.52	120,000	60	63.7
5,000	2.50	7.58	140,000	70	70.6
6,000	3.00	8.56	160,000	80	77.3
7,000	3.50	9.49	200,000	100	89.7
8,000	4.00	10.4	1,000,000	500	264.0
9,000	4.50	11.2	2,000,000	1,000	420.0
10,000	5.00	12.0	6,000,000	3,000	876.0
12,000	6.00	13.6			

TABLE 10. MAXIMUM ALLOWABLE EMISSION RATE FOR PARTICLES IN NEW JERSEY

Potential emission rate from source (lb/hr)	Allowable emission rate (lb/hr)*	Source gas emitted from source (Standard cu ft/min)	Allowable emission rate (lb/hr)†
50 or less	00.5	3,000 or less	0.5
100	01.0	6,000	1.0
1,000	10.0	35,000	6.0
2,000	20.0	70,000	12.0
3,000 or greater	30.0	140,000	24.0
		175,000 or greater	

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*Based on 99 percent efficiency of collection.

†Based on 0.02 grains/scf.

Instructions:

1. From columns 1 and 2 above, determine the allowable emission rate based upon the potential emission rate of solid particles from the source operation as measured by the performance test principles set forth in subsections 3(a) and 3(b) of this subchapter.

2. From columns 3 and 4 above, determine the allowable emission rate based upon the source gas emitted from the source operation. Whenever dilution gas is, for any purpose, added to the source gas from a source operation, the source gas emitted shall be considered to be the gas discharge rate prior to such dilution.

3. The greater of the two emission rates as determined from 1 and 2 above shall be the maximum allowable emission rate. For rates between any two consecutive values stated in columns 1 and 3, the corresponding allowable emission rates shall be as determined by interpolation.

TABLE 11. ALLOWABLE PARTICULATES EMISSION RATE IN WEST VIRGINIA

Operating source operation or total duplicate source operation process weight rate in pounds per hour	Maximum allowable total stack emission rate in pounds per hour for the appropriate process weight and source operation type			
	Type 'a'	Type 'b'	Type 'c'	Type 'd'
0	0	0	0	0
2,500	3	3	9	0.2
5,000	5	5	13	0.8
10,000	10	10	19	1.8
20,000	16	16	26	4.0
30,000	22	22	32	6.2
40,000	28	28	36	8.3
50,000	31	31	40	10.5
100,000	33	33	54	21.2
200,000	37	37	70	21.2
300,000	40	40	80	21.2
400,000	43	46	88	21.2
500,000	47	53	94	21.2
600,000	50	62	99	21.2
700,000	50	71	99	21.2
800,000	50	79	99	21.2
900,000	50	88	99	21.2
1,800,000 and above	50	176	99	21.2

TABLE 12. STATE VISIBLE EMISSION REGULATIONS APPLICABLE TO THE DIRECT MEAT-FIRING INDUSTRY

State	Limits (Ringelman number)
Alabama	1
Alaska	None
Arizona	2
Arkansas	2 existing sources, 1 new source
California	2
Colorado	1
Connecticut	1
Delaware	1
District of Columbia	1
Florida	2 existing sources, 1 new source
Georgia	2
Hawaii	2 existing sources, 1 new source
Idaho	2 existing sources, 1 new source
Illinois	1½
Indiana	2
Iowa	2
Kansas	2 existing sources, 1 new source
Kentucky	1
Louisiana	1
Maine	2
Maryland	0
Massachusetts	1
Michigan	1
Minnesota	1
Mississippi	2
Missouri	2 existing sources, 1 new source
Montana	None
Nebraska	1
Nevada	1
New Hampshire	2 existing sources, 1 new source
New Jersey	None
New Mexico	1
New York	2 existing sources, 1 new source
North Carolina	2 existing sources, 1 new source
North Dakota	2 existing sources, 1 new source
Ohio	1

(continued)

TABLE 12 (continued)

State	Limits (Ringelman number)
Oklahoma	1
Oregon	2 existing sources, 1 new source
Pennsylvania	1
Rhode Island	1
South Carolina	2
South Dakota	3
Tennessee	2 existing sources, 1 new source
Texas	1½ existing sources, 1 new source
Utah	2 existing sources, 1 new source
Vermont	2 existing sources, 1 new source
Virginia	1
Washington	2 existing sources, 1 new source

TABLE 13. GASEOUS ORGANIC MATERIAL STANDARDS APPLICABLE TO THE DIRECT MEAT-FIRING INDUSTRY

Agency	Standard
California Bay area air pollution control district	50 ppm as hexane or 300 ppm as total carbon

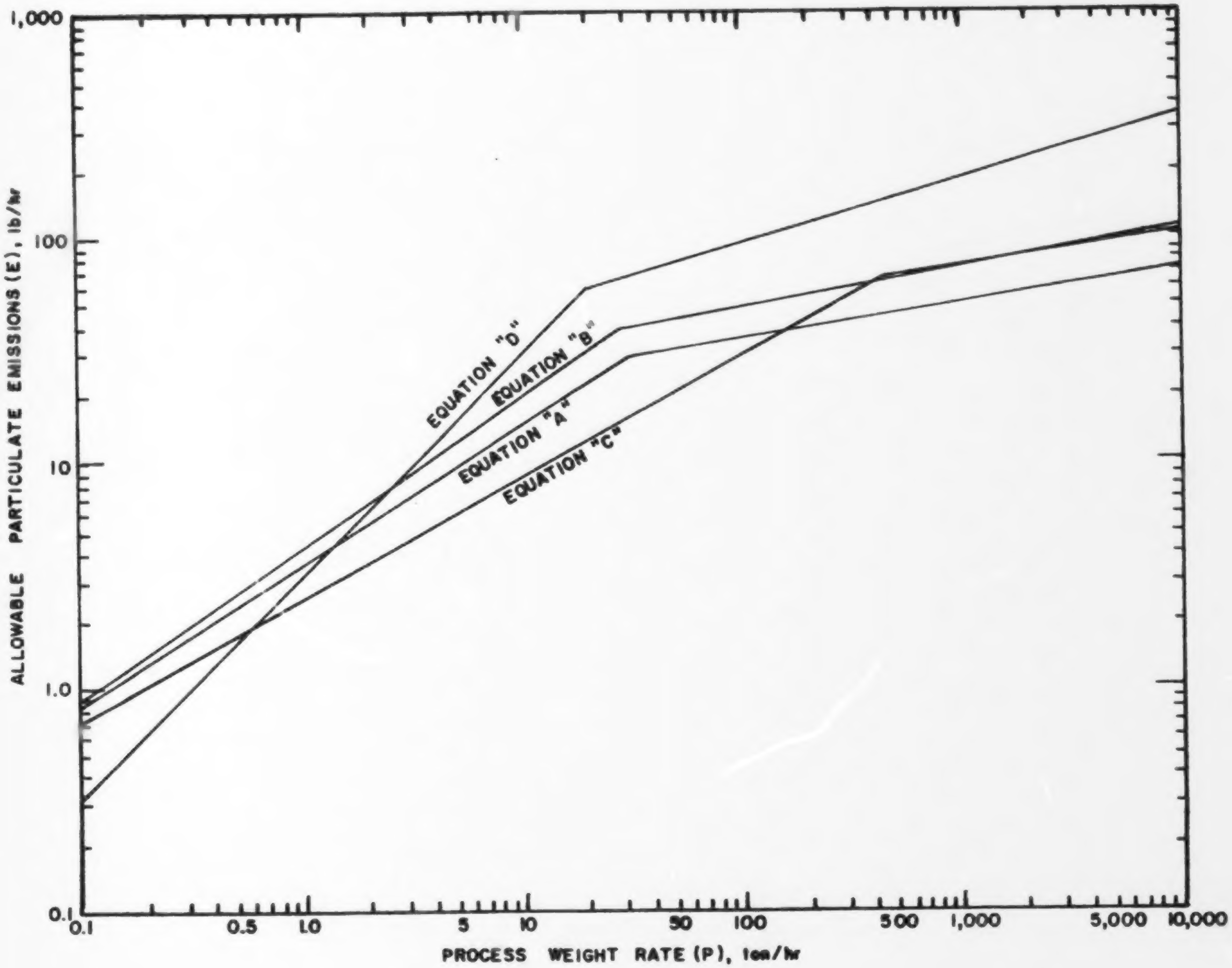

Figure 13. Plot of process weight equations used in Table 6.

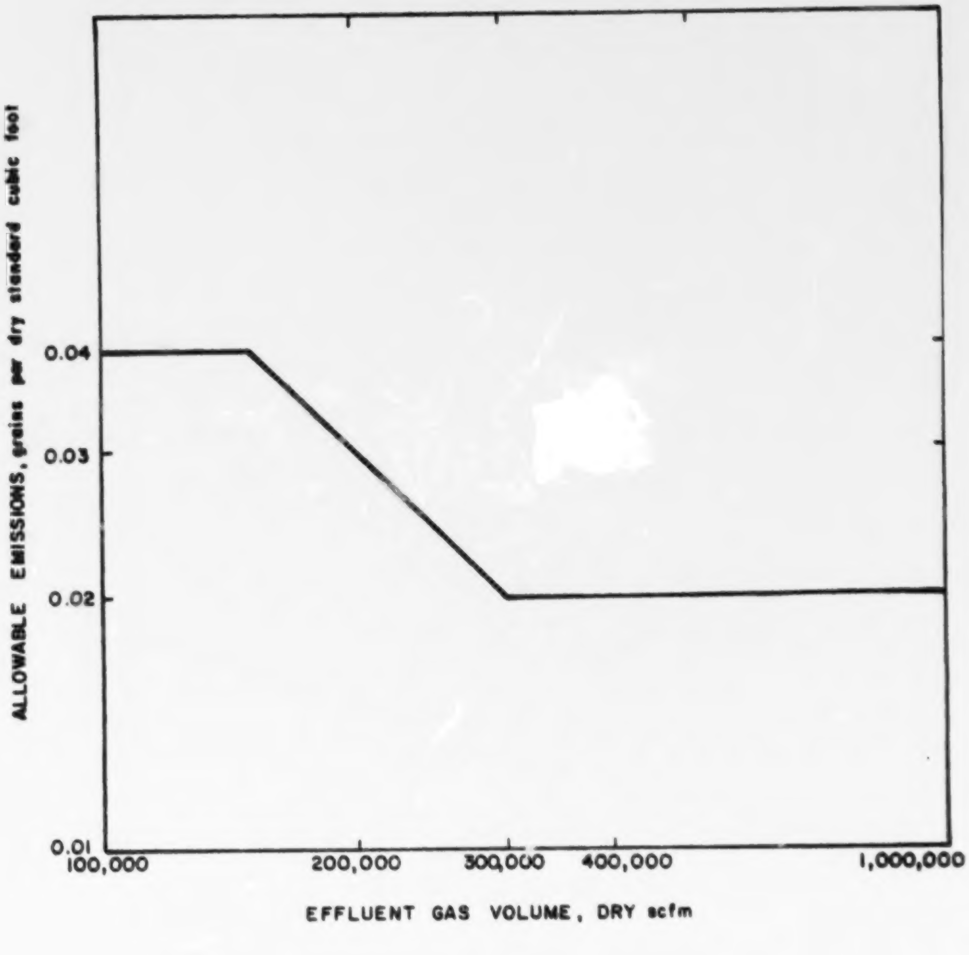

Figure 14. Allowable particulate emissions in Pennsylvania.

SECTION 6

EMISSION REDUCTION WITH NEW SOURCE PERFORMANCE STANDARDS

INTRODUCTION

The main purpose of this study is to determine the effect of New Source Performance Standards on emissions of particulates and gaseous organic materials from facilities using direct meat firing. The appraisal of these proposed standards is to be determined by the use of a model developed by TRC[41] called Model IV. To use Model IV, it is necessary to determine parameters concerning three major areas:

- number and distribution by state of direct meat-firing units
- annual increase in number of units due to replacement and new installations
- emission rates of these facilities under existing state regulations.

Emission rates are determined for both uncontrolled facilities and those using best available control technology. Emissions under existing state regulations were estimated for two cases. Essentially, no state enforces particulate process weight regulations on direct meat-firing facilities. For this case, it was assumed that emission rates under present state regulations are equal to uncontrolled emission rates. For the second case, average allowable emissions were estimated to indicate emission levels if all states enforced existing regulations. This emission rate was determined from state process weight regulations taken at the minimum process weight rate, since most direct meat-firing facilities use very low process throughputs, usually less than 45.5 kg (100 lb/hr).

This section presents results of Model IV calculations which indicate emission levels expected in 1988 for three control options.

- No control (existing condition)
- Stringent enforcement of existing state regulations based on process weight rate
- Promulgation of New Source Performance Standards based on best available control technology.

MODEL IV - BACKGROUND INFORMATION

The additional control potential of new or revised standards of performance stems from the application of emission standards that are more stringent than those presently applied to construction and modification. This potential, for a specified time period, is expressed as:

$$(T_S - T_N)$$

where T_S = emissions under baseline year control regulations

T_N = emissions under new or revised standards of performance.

To calculate the control potential of standards of performance, other factors must be considered, such as the portion of growth requirements that can be satisfied from present unused capacity and the obsolescence and replacement rates of existing facilities. Such a comparison can be expressed mathematically.

The following notation is used in the development of the relationship between projected emissions under baseline year (1977) regulations and NSPS control:

T_S = total emission in i^{th} year under baseline year regulations (tons/yr)

T_N = total emissions in i^{th} year under new or revised NSPS which have been promulgated in the j^{th} year (tons/yr)

T_U = total emissions in i^{th} year assuming no control (tons/yr)

T_A = total emissions in baseline year under baseline year regulations (tons/yr)

K = normal fractional utilization rate of existing capacity, assumed constant during time interval

A = baseline year production capacity (production units/yr)

B = production capacity from construction and modification to replacement obsolete facilities (production units/yr)

C = production capacity from construction and modification to increase output above baseline year capacity (production units/yr)

P_B = construction and modification rate to replace obsolete capacity (decimal fraction of baseline capacity/yr)

P_C = construction and modification rate to increase industry capacity (decimal fraction of baseline capacity/yr)

E_S = allowable emissions under existing regulations (mass/unit capacity)

E_N = allowable emissions under standards of performance (mass/unit capacity)

E_U = emissions with no control (mass/unit capacity)

For the purpose of this study, the i^{th} year is defined as 1988 and the j^{th} year, 1977.

Assuming that capacity lost due to obsolescence is replaced by construction and modification, then:

$$T_S = E_S\ K\ (A - B) + E_S\ K\ (B + C) \qquad (1)$$

and

$$T_N = E_S\ K\ (A - B) + E_N\ K\ (B + C) \qquad (2)$$

$$T_S - T_N = K\ (B + C)\ (E_S - E_N) \qquad (3)$$

If simple growth is assumed, values of B and C are determined as follows:

$$B = AiP_B \qquad (4)$$

$$C = AiP_C \qquad (5)$$

If compound growth is assumed, values of B and C are determined as follows:

$$B = A \quad (1 + P_B)^i - 1 \qquad (6)$$

$$C = A \quad (1 + P_C)^i - 1 \qquad (7)$$

where i = elapsed time, years

In addition, the following values may be calculated:

$$T_A = E_S KA \qquad (8)$$

$$T_U = E_U K\ (A - B) + E_U K\ (B + C) \qquad (9)$$

Further refinement of the Model may be realized for cases where E_S for new and existing plants differ. In this case,

$$T_S = KE_{S_1}\ (A - B) + KE_{S_2}\ (B + C) \qquad (10)$$

where $E_{S_1} = E_S$ for existing plants

$E_{S_2} = E_S$ for new plants.

Therefore,

$$T_S - T_N = K (B + C) (E_{S_2} - E_N) \qquad (11)$$

MODEL IV INPUT PARAMETERS

Number of Direct Meat-Firing Units

To determine the total number of direct meat-firing facilities and the distribution by state, GCA relied primarily on the following sources: (1) a directory[1] listing all chain operated restaurants in the country, (2) the U.S. Census listing of all restaurants, and (3) the telephone yellow pages. Seattle, Washington; Jacksonville, Florida; Kansas City, Missouri; and Boston, Massachusetts were considered to be a representative cross-section of the country. Data from these sources and from industry and state contacts indicated that 9 percent or approximately 32,000 restaurants use direct meat firing.[42-44] Approximately 1 percent (300 units) are charcoal/wood-fired charbroilers,[14] 85.6 percent (27,400 units) are gas-fired charbroilers[14] and the remaining 1.6 percent (500 units) are barbecues.[1] It was not possible to determine for each state the type of direct meat firing used. The estimated number of direct meat-firing facilities in each state was presented previously in Table 1 and were used in Model IV calculations.

Emission Factors

Uncontrolled emission rates (E_U) used in Model IV calculations were obtained from limited test data and are presented in Section 3.

Emission rates for direct meat-firing facilities under existing state regulations (E_S) were estimated with two different approaches. Since essentially all states are not enforcing particulate process weight regulations for restaurants, it was assumed that emission rates under present state regulations are equivalent to emission rates for uncontrolled sources. By setting E_S equal to E_U, the existing level of emissions can be calculated. The second method involved determining a weighted, average allowable state emission rate (E_{SAVG}), assuming that all states enforce their regulations. The calculation of E_{SAVG} is shown in Table 14 based on using the state minimum process weight throughput of 100 lbs/hr. For use in the model, units were changed to be consistent with the calculations. Therefore, hourly emission rates were converted to yearly rates by multiplying by the average number of hours a direct meat firing facility operates in a year, 4,380 hours.

Emission rates representing the use of best available control technology were calculated by simply multiplying the uncontrolled emission rate by

TABLE 14. AVERAGE ALLOWABLE PARTICULATE EMISSIONS UNDER PRESENT STATE REGULATIONS

State	Fraction of total number of units A_i	Allowable emissions lb/hr E_S*	A_i × allowable
Alabama	0.013	0.56	0.0073
Alaska	0.002	0.64	0.0013
Arizona	0.010	0.55	0.0055
Arkansas	0.011	0.56	0.0062
California	0.108	0.55	0.0594
Colorado	0.013	0.56	0.0073
Connecticut	0.015	0.56	0.0084
Delaware	0.003	2.6	0.0078
District of Columbia	0.004	0.39	0.0016
Florida	0.039	0.56	0.0218
Georgia	0.020	0.55	0.0110
Hawaii	0.004	0.55	0.0022
Idaho	0.005	0.55	0.0028
Illinois	0.054	0.51	0.0275
Indiana	0.024	0.55	0.0132
Iowa	0.016	0.55	0.0088
Kansas	0.013	0.55	0.0072
Kentucky	0.013	0.56	0.0073
Louisiana	0.016	0.55	0.0088
Maine	0.006	0.56	0.0034
Maryland	0.014	0.24	0.0034
Massachusetts	0.029	0.24	0.0070
Michigan	0.036	0.55	0.0198
Minnesota	0.018	0.56	0.0101
Mississippi	0.010	0.55	0.0055
Missouri	0.024	0.55	0.0132
Montana	0.003	0.55	0.0016
Nebraska	0.008	0.55	0.0044
Nevada	0.003	0.55	0.0017
New Hampshire	0.005	0.55	0.0028
New Jersey	0.031	0.50	0.0155
New Mexico†	0.006	0.72	0.0043
New York†	0.096	0.72	0.0691
North Carolina	0.022	0.55	0.0121
North Dakota	0.004	0.55	0.0022
Ohio	0.047	0.55	0.0259
Oklahoma	0.016	0.55	0.0088
Oregon	0.012	0.24	0.0029
Pennsylvania	0.052	0.51	0.0265
Rhode Island	0.005	0.55	0.0028
South Carolina	0.012	0.55	0.0066
South Dakota	0.004	0.55	0.0022
Tennessee	0.019	0.56	0.0106
Texas	0.061	0.16	0.0098

TABLE 14 (continued). AVERAGE ALLOWABLE PARTICULATE EMISSIONS UNDER PRESENT STATE REGULATIONS

State	Fraction of total number of units A_i	Allowable emissions lb/hr E_S*	A_i × allowable
Utah†	0.006	0.72	0.0043
Vermont	0.003	0.24	0.0007
Virginia	0.019	0.55	0.0105
Washington†	0.016	0.72	0.0115
West Virginia†	0.008	0.72	0.0058
Wisconsin	0.022	0.56	0.0123
Wyoming	0.002	0.56	0.0011

$\Sigma = 0.5338$ lb/hr

$E_{SAVG} = 0.53$ lb/hr

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*Based on 100 lb/hr throughput.

†No regulation; assume E_S = average E_U = 0.72 lb/hr.

$$\frac{100 - \%\ \text{efficiency}}{100}$$

where particulate control is 93 percent and gaseous organic control is 99 percent.

"K" Factor

The factor "K", defined as "normal fractional utilization rate of existing capacity, assumed constant during time interval" was determined for each of the four methods of direct meat firing based on procedures used during stack testing (see Section 3). Since Model IV calculations should reflect typical or average data for an industry, emission rates should also represent average or typical values. For barbecues and charcoal-wood-fired charbroilers, stack tests were conducted under normal operating conditions. Therefore, the value of "K" chosen for calculations pertaining to these two categories is 1.0. This is not intended to mean that these two categories are using 100 percent of capacity. But because of the way the stack tests were conducted (normal operating conditions) and because an operating unit (A, B, C) is equal to one restaurant, it was necessary for the purpose of performing the Model IV calculations that K remain equal to 1.0.

Tests conducted by Hardee's for a gas-fired charbroiler, the results of which were assumed equal to an electric-fired charbroiler,[11] were conducted under saturated grill conditions. The amount of meat cooked during these saturated conditions was approximately 45.5 kg (100 pounds) per hour. The maximum daily capacity based on an average 12-hour day is 545.5 kg (1200 pounds). However, the average daily meat consumption in restaurants, determined from the United States Department of Agriculture data[3] and from conversations with industry contacts,[6-11] is approximately 77.3 kg (170 pounds) per restaurant. Dividing the actual consumption by the maximum possible consumption results in a "K" factor of 0.14. This indicates that the typical gas- and electric-fired charbroiling restaurant uses only about 14 percent of maximum grill capacity over a 12-hour day.

"P_C" Factor

The factor "P_C" defined as "construction and modification rate to increase industry capacity (decimal fraction of baseline capacity/year)" was determined from the past historical growth rate of chain operated restaurants.[1] It is assumed that direct meat firing facilities will expand and grow at the same rate anticipated for chain operated restaurants, since the greatest percentage of direct meat-firing is at chain restaurants. Based on data for the years 1972 to 1977, P_C is estimated at 0.071, using compounded growth.

"P_B" Factor

The factor "P_B" defined as "construction and modification rate to replace obsolete capacity (decimal fraction of baseline capacity/year)" was based on conversations with equipment manufacturers.[42,45] These manufacturers stated that equipment will last approximately 10 to 15 years before requiring replacement. A liberal figure of 15 years was chosen for determining P_B. Based on simple growth, P_B is equal to 0.067.

RESULTS OF MODEL IV CALCULATIONS

Model IV calculations were performed for the four types of direct meat-firing units for the two pollutants of interest, particulates and gaseous organic materials. Values for T_N, T_A, and T_S (with no enforcement by the states) and T_{SAVG} (assuming all states enforce particulate process weight regulations) were determined and are presented in Tables 15, 16, and 17.

The total (T_S - T_N) for particulate 7.93×10^7 kg (87,222 tons) represents 81.5 percent of T_S. In other words, the potential reduction in emissions by application of NSPS represents 81.5 percent of the total emissions that would result in 1988 under the present nonenforcement of state regulations. If present state regulations are enforced and NSPS are not promulgated, emissions could be reduced by 8.64×10^7 kg (95,020 tons) or 88.7 percent of the total anticipated emissions for 1988.

If present state regulations are enforced and NSPS are promulgated, the reduction from both enforcement and NSPS would be 92.5 percent or 9.0×10^7 kg (99,000 tons) by 1988 compared to emissions under present day nonenforcement.

The reduction expected from NSPS for gaseous organic emissions is 86.7 percent or 32,010 tons of potential uncontrolled emissions in 1988. If NSPS are not promulgated, gaseous organic emissions will more than double from the present day 1.58×10^7 kg (17,371 tons).

TABLE 15. MODEL IV RESULTS - PARTICULATES ASSUMING $E_S = E_U$

Category	K	Units	Emission rates			Growth rate decimal/yr		Industry capacity*				Emission ton/yr			Impact ton/yr
			E_U	E_S	E_N	P_C	P_B	Units/ yr	A 1977	B 1988	C 1988	T_A 1977	T_S 1988	T_N 1988	T_S-T_N
Barbecue	1.0	lb/unit-yr	1,095	1,095	76.7	0.071 c	0.067 s	10^6 units	0.0005	0.0004	0.0005	270	582	107	475
Charcoal/wood charbroiler	1.0	lb/unit-yr	2,102.4	2,102.4	147.2	0.071 c	0.067 s	10^6 units	0.0003	0.0002	0.0003	320	671	124	547
Gas charbroiler	0.14	lb/unit-yr	22,776	22,776	1,594	0.071 c	0.067 s	10^6 units	0.0274	0.0202	0.0309	43,700	92,900	17,200	75,700
Electric charbroiler	0.14	lb/unit-yr	22,776	22,776	1,594	0.071 c	0.067 s	10^6 units	0.0038	0.0028	0.0043	6,060	12,900	2,400	10,500
										Totals		50,350	107,053	19,831	87,222

*A, B, C are equal to number of restaurants.

TABLE 16. MODEL IV RESULTS - PARTICULATES USING E_{SAVG} AND ENFORCEMENT BY STATES

Category	K	Units	Emission rates			Growth rate decimal/yr		Industry capacity*				Emission ton/yr			Impact ton/yr
			E_U	E_{SAVG}	E_N	P_C	P_B	Units/ yr	A 1977	B 1988	C 1988	T_A 1977	T_{SAVG} 1988	T_N 1988	T_S-T_N
Barbecue†												270	582	107	475
Charcoal/wood charbroiler†												320	671	124	547
Gas charbroiler	0.14	lb/unit-yr	22,776	2,321	1,594	0.071 c	0.067 s	10^6 units	0.0274	0.0202	0.0309	43,700	9,467	6,869	2,598
Electric charbroiler	0.14	lb/unit-yr	22,776	2,321	1,594	0.071 c	0.067 s	10^6 units	0.0038	0.0028	0.0043	6,060	1,313	953	360
										Totals		50,350	12,033	8,053	3,980

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*A,B,C are equal to number of restaurants.

†Calculations the same as performed in previous table since E_U is less than E_S average.

TABLE 17. MODEL IV RESULTS - GASEOUS ORGANIC EMISSIONS

Category	K	Units	Emission rates			Growth rate decimal/yr		Industry capacity[a]				Emission 1000 ton/yr			Impact ton/yr
			E_U	E_S	E_N	P_C	P_B	Units/ yr	A 1977	B 1988	C 1988	T_A 1977	T_S 1988	T_N 1988	T_S-T_N
Barbecue	1.0	lb/unit-yr	3,285	3,285	32.85	0.071 c	0.067 s	10^6 units	0.0005	0.0004	0.0005	821	1,750	240	1,510
Charcoal/wood charbroiler	1.0	lb/unit-yr	6,307	6,307	63.07	0.071 c	0.067 s	10^6 units	0.0003	0.0002	0.0003	950	2,010	270	1,740
Gas charbroiler	0.14	lb/unit-yr	7,139	7,139	71.39	0.071 c	0.067 s	10^6 units	0.0274	0.0202	0.0309	13,700	29,120	3,860	25,260
Electric charbroiler	0.14	lb/unit-yr	7,139	7,139	71.39	0.071 c	0.067 s	10^6 units	0.0038	0.0028	0.0043	1,900	4,040	540	3,500
										Totals		17,371	36,920	4,910	32,010

[a] A,B,C are equal to number of restaurants.

SECTION 7

MODIFICATION AND RECONSTRUCTION

New Source Performance Standards are applicable to existing facilities that are modified or reconstructed in a way that increases the mass rate of emissions. The modification of an existing commercial charbroiling operation or barbecue is extremely rare. What is usually modified at a restaurant is the dining or kitchen area, not the actual method of cooking.[11,31] Repair or replacement of individual components of a direct meat-firing operation may take place, but will not cause an increase in emissions. The following major components would be subject to repair or replacement:

1. Grill
2. Electrical heaters
3. Radiants ("larva rocks," ceramic, etc.)
4. Gas burners
5. Gas regulator
6. Grease tray

If any of these components are changed, it is unlikely that the emissions would increase since the operation would become more efficient and the primary influencing factor, the fat content of the meat, would remain essentially the same.

The application of standards of performance for new stationary sources can most easily be defined as covering new restaurant installations or the replacement of an existing exempt operation, such as a flat or grooved griddle, with a direct meat firing operation (charbroiler or barbecue).

We were unable to locate specific cases where this type of modification has or will take place.

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APPENDIX A

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617-742-2947

APPENDIX B

REPORTS AND CORRESPONDENCE

This section includes copies of all letters written, responses received, meeting or trip reports and telephone summaries that resulted from this study.

REPORT OF TELEPHONE CONVERSATION
DIRECT MEAT FIRING INDUSTRY

DATE: 5/5/77

PERSON CALLED: Dave Hughes

ORGANIZATION: Langston Labs

ADDRESS: 2005 West 103rd Terrace
Leawood, Kansas 66206

TEL. NO. 913-341-7800

GCA PERSONNEL: M.B.

SUBJECT MATTER:

Langston Labs performed stack sampling for a charcoal burning restaurant in Kansas City during 1974. Data is available in an EPA Report 650/2-75-007 NTIS PB-243-362. This sampling effort was primarily for PCB and POM. I called Langston to obtain the actual raw data for the 13 tests that were performed. Dave Hughes was very cooperative over the phone and is going to try and obtain the information that I requested.

REPORT OF TELEPHONE CONVERSATION

DIRECT MEAT FIRING INDUSTRY

DATE: 5/9/77

PERSON CALLED: Dr. Ratney

ORGANIZATION: OSHA

ADDRESS: Boston, Ma.

TEL. NO. 617-223-6712

GCA PERSONNEL: M.B.

SUBJECT MATTER:

OSHA was contacted to see if any studies were performed in the past concerning restaurants. Dr. Ratney stated that since no citations were issued there were no tests conducted.

Two pollutants of interest that were mentioned are acrolein and condensed grease. OSHA limits are 0.1 mg/m^3 and 5 mg/m^3 respectively. No reports of any restaurant exceeding these limits have been recorded by OSHA.

REPORT OF TELEPHONE CONVERSATION

DIRECT MEAT FIRING INDUSTRY

DATE: 5/9/77

PERSON CALLED: Jim Francis

ORGANIZATION: Bureau of Air Quality and Noise Control
Maryland State Dept. of Health and Mental Hygiene

ADDRESS: 201 West Preston St.
Baltimore, Md. 21203

TEL. NO. 301-303-3147

GCA PERSONNEL: M.B.

SUBJECT MATTER:

Jim is currently working on a report entitled, "Control of Air Pollution from Restaurant Char-Broilers." Three systems have been approved by the State for meeting their opacity regulations.

	Capital Costs	Operating Costs
1. Afterburners	$6,000	$2,000/month
2. ESP with a cleaning device	$12 - 15,000	$80/month
3. Conqueror by Hardee's (filter pad and detergent cleaning)	$10,000	$150/month

Their report is still in the draft stage but Jim stated that he might be able to send me a copy if I requested it in writing. I will do so.

GCA/TECHNOLOGY DIVISION

May 9, 1977

Mr. Jim Francis
Bureau of Air Quality and Noise Control
Maryland State Department of Health and Mental Hygiene
201 West Preston Street
Baltimore, Maryland 21203

Dear Mr. Francis:

Per our telephone conversation on Monday, May 9, 1977, I would like to obtain a copy of your report entitled, "Control of Air Pollution from Restaurant Char-Broilers." This information will be used by GCA for a current contract with the U.S. EPA. This contract deals with obtaining background information for the direct meat firing industry and will be used for developing possible new source performance standards.

Sincerely,

Mark Bornstein

Mark Bornstein

MB:NC

URLINGTON ROAD, BEDFORD, MASSACHUSETTS 01730 / PHONE: 617-275-9000

REPORT OF TELEPHONE CONVERSATION

DIRECT MEAT FIRING INDUSTRY

DATE: 5/9/77

PERSON CALLED: Mr. Al Bailey

ORGANIZATION: Southern California APCD

ADDRESS: 434 S. San Pedro St.
L.A., California 90013

TEL. NO. 213-974-7517

GCA PERSONNEL: M.B.

SUBJECT MATTER:

This agency was contacted to determine if any reports or emissions data may be available. Mr. Bailey stated that he knew of only one such emission test but that others may be available. He suggested that I write a formal report and address it to Mr. Robert J. MacKnight, Director of Engineering. I will do so.

GCA/TECHNOLOGY DIVISION

May 9,1977

Mr. Robert J. MacKnight
Director of Engineering
Southern California Air Management District
434 South San Pedro Street
Los Angeles, California 90013

Dear Mr. MacKnight:

GCA is presently under contract with the U.S. EPA to develop background information for the direct meat firing industry. This information will be used to develop emission factors which will assist in the development of possible new source performance standards for this industry.

If possible, I would like to obtain copies of any stack test data that you might have with regard to the following categories:

1. Char broilers at restaurants
2. Barbecue type restaurants
3. Any other cooking process where the meat comes in direct contact with the flames

If there are any problems or if you need further clarification, please call.

Sincerely yours,

Mark Bornstein

MB:NC

BURLINGTON ROAD, BEDFORD, MASSACHUSETTS 01730 / PHONE: 617-275-9000

AIR POLLUTION CONTROL DISTRICT - COUNTY OF LOS ANGELES

TEST NO. C-2386

PAGE 4
DATE 1-6-76

SUMMARY OF DATA AND RESULTS
(For Evaluation)

EQUIPMENT AND TEST CONDITIONS

Name of Firm Leo's Bar-B-Cue Company
Basic Equipment Barbecue Oven
Control Equipment Direct gas-fired afterburner
Process Description Meat cooking
Test Date January 6, 1976

Nominal Temp. °F.	1200	1000	800
A/B Temperature, °F			
Plant instrument	1210	1090	850
APCD measurement	(avg) 1150	1040	830

RESULTS

A/B Inlet

Concentrations as CO_2, ppm. by volume, dry basis			
CO	280	369	392
CO_2	2200	2390	3020
Total Organics	266	208	394
Gas flow rate, scfm (dry)	1370	1400	1360
Gas temperature, °F			

A/B Outlet

Concentrations as CO_2, ppm. by volume, dry basis			
CO	1360	1120	1050
CO_2	30700	26800	20800
Total Organics	843	1420	2090
(*)	1920	2170	2750
Gas flow rate, scfm (dry)	1330	1370	1340
Gas temperature, °F	1150	1040	830

EMISSION RATES AND AFTERBURNER EFFICIENCY

Organics, as carbon, lb./hr.			
Inlet	0.69	0.55	1.0
Outlet*	5.0	5.6	7.0
Efficiency, %	Neg.	Neg.	Neg.
Aldehydes as HCHO		(Outlet)	
ppm by vol.	55	101	106
lb./hr.	0.4	0.7	0.7

NOTES: (*) Including increase in CO, if any, across the afterburner

AIR POLLUTION CONTROL DISTRICT - COUNTY OF LOS ANGELES

TEST NO. C-2386

PAGE 5
DATE 1-6-76

SUMMARY OF DATA AND RESULTS

TEST SITE, EQUIPMENT, AND TEST CONDITIONS:

1. NAME OF FIRM Leo's Bar-B-Cue Company
2. BASIC EQUIPMENT Barbecue Oven
3. CONTROL EQUIPMENT Direct gas-fired afterburner
4. EQUIPMENT TESTED Afterburner
5. PROCESS WEIGHT, LBS PER HOUR 70
6. TESTING CONDITION 1200°F

7. SAMPLING LOCATION:	Afterburner Inlet	Afterburner Outlet
GAS FLOW AND ANALYSIS:		
8. GAS TEMPERATURE, °F	70	1150
9. GAS VELOCITY, FPS	30.2	
10. GAS FLOW RATE, SCFM (WET)	1400	
GAS FLOW RATE, SCFM (DRY)	1370	1330
11. GAS ANALYSIS, VOL %, DRY BASIS:		
CARBON DIOXIDE	0.22	3.07
OXYGEN	21	15.5
CARBON MONOXIDE	0.028	0.136
NITROGEN	78.8	81.3
12. GAS ANALYSIS, VOL %, WET BASIS:		
WATER VAPOR	2.3	
CARBON DIOXIDE		
OXYGEN		
CARBON MONOXIDE		
NITROGEN		
AIR CONTAMINANTS MEASURED:		
13. MATERIAL COLLECTED	Particulates	
14. TOTAL GAS VOLUME SAMPLED, SCF	(dry) 47.87	39.34
15. WEIGHT COLLECTED, GRAMS	0.060	0.037
16. MATERIAL CONCENTRATION:		
GRAINS PER SCF (WET)		0.0145
GRAINS PER SCF (DRY)	0.0193	
GRAINS PER SCF AT 12% CO_2		
PARTS PER MILLION BY VOLUME		
17. MATERIAL FLOW RATE, LBS PER HOUR	0.23	0.17
NO_x as NO_2 (Outlet)		
18. PPM by Vol.		11
19. Lbs Per Hour		0.1
20. EFFICIENCY, %		

AIR POLLUTION CONTROL DISTRICT - COUNTY OF LOS ANGELES

TEST NO. C-2386

SUMMARY OF DATA AND RESULTS

PAGE 6
DATE 1-6-76

TEST SITE, EQUIPMENT, AND TEST CONDITIONS:

1. NAME OF FIRM Leo's Bar-B-Cue Company
2. BASIC EQUIPMENT Barbecue Oven
3. CONTROL EQUIPMENT Direct gas-fired afterburner
4. EQUIPMENT TESTED Afterburner
5. PROCESS WEIGHT, LBS PER HOUR ⑦⓪
6. TESTING CONDITION 1000°F

7. SAMPLING LOCATION:	Afterburner Inlet	Afterburner Outlet
GAS FLOW AND ANALYSIS:		
8. GAS TEMPERATURE, °F	70	1040
9. GAS VELOCITY, FPS	30.9	
10. GAS FLOW RATE, SCFM (WET)	1440	
GAS FLOW RATE, SCFM (DRY)	1400	1370
11. GAS ANALYSIS, VOL %, DRY BASIS:		
CARBON DIOXIDE	0.239	2.68
OXYGEN	21	16.2
CARBON MONOXIDE	0.0369	0.112
NITROGEN	78.8	81.0
12. GAS ANALYSIS, VOL %, WET BASIS:		
WATER VAPOR	2.8	
CARBON DIOXIDE		
OXYGEN		
CARBON MONOXIDE		
NITROGEN		
AIR CONTAMINANTS MEASURED:		
13. MATERIAL COLLECTED	Particulates	
14. TOTAL GAS VOLUME SAMPLED, SCF	37.09	31.07
15. WEIGHT COLLECTED, GRAMS	0.049	0.025
16. MATERIAL CONCENTRATION:		
GRAINS PER SCF (WET)		
GRAINS PER SCF (DRY)	0.0204	0.0124
GRAINS PER SCF AT 12% CO_2		
PARTS PER MILLION BY VOLUME		
17. MATERIAL FLOW RATE, LBS PER HOUR	0.24	0.15
NO_x as NO_2 (Outlet)		
18. PPM by Vol		8
19. Lbs Per Hour		0.08
20. EFFICIENCY, %		

AIR POLLUTION CONTROL DISTRICT - COUNTY OF LOS ANGELES

PAGE 7
DATE 1-6-76

TEST NO. C-2386

SUMMARY OF DATA AND RESULTS

TEST SITE, EQUIPMENT, AND TEST CONDITIONS:

1. NAME OF FIRM Leo's Bar-B-Cue Company
2. BASIC EQUIPMENT Barbecue Oven
3. CONTROL EQUIPMENT Direct gas-fired afterburner
4. EQUIPMENT TESTED Afterburner.
5. PROCESS WEIGHT, LBS PER HOUR 70
6. TESTING CONDITION 800°F

7. SAMPLING LOCATION:	Afterburner Inlet	Afterburner Outlet
GAS FLOW AND ANALYSIS:		
8. GAS TEMPERATURE, °F	80	830
9. GAS VELOCITY, FPS	30.7	
10. GAS FLOW RATE, SCFM (WET)	1410	
GAS FLOW RATE, SCFM (DRY)	1360	1340
11. GAS ANALYSIS, VOL %, DRY BASIS:		
CARBON DIOXIDE	0.302	2.08
OXYGEN	21	17.5
CARBON MONOXIDE	0.0392	0.105
NITROGEN	78.7	80.3
12. GAS ANALYSIS, VOL %, WET BASIS:		
WATER VAPOR	3.2	
CARBON DIOXIDE		
OXYGEN		
CARBON MONOXIDE		
NITROGEN		
AIR CONTAMINANTS MEASURED:		
13. MATERIAL COLLECTED	Particulates	
14. TOTAL GAS VOLUME SAMPLED, SCF	37.59	31.12
15. WEIGHT COLLECTED, GRAMS	0.058	0.036
16. MATERIAL CONCENTRATION:		
GRAINS PER SCF (WET)		
GRAINS PER SCF (DRY)	0.0238	0.0178
GRAINS PER SCF AT 12% CO_2		
PARTS PER MILLION BY VOLUME		
17. MATERIAL FLOW RATE, LBS PER HOUR	0.28	0.20
NO_x as NO_2 (Outlet)		
18. PPM by Vol		6
19. Lbs Per Hour		0.06
20. EFFICIENCY, %		

GCA/TECHNOLOGY DIVISION

May 9, 1977

Toastmaster
McGraw Edison Company
Toastmaster Commercial Division
Algonquin, Illinois 60102

Dear Sir:

Would you please send me further information concerning char broilers. I am interested in knowing about any available air pollution control equipment that may be suitable for your broilers. Do you have any background data or test data that may support any guarantee on meeting opacity or particulate regulations.

Sincerely,

Mark Bornstein

Mark Bornstein

MB:NC

BURLINGTON ROAD, BEDFORD, MASSACHUSETTS 01730 / PHONE: 617-275-9000

TOASTMASTER COMMERCIAL DIVISION
McGraw-Edison Company
Washington Street, Algonquin, Illinois 60102 · (312) 658-4511 Telex: 72-2446

May 13, 1977

GCA/Technology Division
Burlington Road
Bedford, MA 01730

Attention: Mr. Mark Bornstein

Dear Mr. Bornstein:

Thank you for your interest in Toastmaster commercial kitchen appliances.

As you are aware, we manufacture the appliance itself and have no relationship with the air handling systems that may be installed by the individual restaurant to control pollution or meet local requirements. Inherently electric char broiling produces less contaminants than a flamefired device but local interpretation of air quality standard varies greatly and, therefore, place the responsibility upon the restaurateur to meet codes.

May we suggest you address your inquiries to those people in the industry who manufacture air handling equipment. One such firm is our sister division, Seco Engineering Products, located in St. Louis, Missouri.

Sincerely,

D.A.Grill
National Sales Manager

DAG:n

REPORT OF TELEPHONE CONVERSATION
DIRECT MEAT FIRING INDUSTRY

DATE: 5/12/77

PERSON CALLED: ____________________

ORGANIZATION: Chain Store Guide

ADDRESS: 425 Park Ave.
NYC, N.Y. 10022

TEL. NO. 312-371-9400

GCA PERSONNEL: M.B.

SUBJECT MATTER:

This firm publishes a listing of all food chain restaurants in the country. We are purchasing a copy of

"The Directory of Chain Restaurant Operations."

REPORT OF TELEPHONE CONVERSATION

DIRECT MEAT FIRING INDUSTRY

DATE: 5/12/77

PERSON CALLED: Dr. Poledor

ORGANIZATION: National Restaurant Assoc.

ADDRESS: One IBM Plaza Suite 2600

Chicago, Illinois 60611

TEL. NO. 312-787-2525

GCA PERSONNEL: M.B.

SUBJECT MATTER:

Dr. Poledor informed me that from May 22 to May 25 there will be an exhibit sponsored by their organization to be held in Chicago at Mc Cormick Place. Approximately 800 companies will be represented during the show. There will be several workshops as well as the exhibits.

MIDWEST RESEARCH INSTITUT
425 Volker Boulevar
Kansas City, Missouri 64110
Telephone (816) 561-020

April 23, 1976

Dr. William P. Fisher
Executive Vice President
National Restaurant Association
Suite 2600, 1 IBM Plaza
Chicago, Illinois 60611

Subject: Report on Phase 1 (Emissions Sampling and Testing) of project entitled, "Sampling and Analysis of Charcoal Grill Emissions," MRI Project No. 4206-C.

Dear Dr. Fisher:

This letter report summarizes activities carried out under Phase 1 of the above project and presents emission data obtained from tests conducted at the Hereford House.

Summary of Activities

On March 23, a pretest visit was made to the Hereford House. At that time, the charcoal grill and the stack were inspected and necessary arrangements made for the emissions tests. The tests were conducted on March 31, 1976.

Duct extensions were placed on each of the two exhaust fans serving the grills and each duct was sampled during the 2-hr sampling period for each process (lunch-hamburger, afternoon-slack, supper-steak). Meat counts were taken for each period to determine the amount of meat cooked during the sampling period. The count for steaks should be used with caution due to varying custom weights on the meat which was cooked to customer order Test procedures adopted for sample and velocity traverses and for particulate sampling followed EPA Test Methods 1 and 5, respectively.* Emission data obtained from the tests are discussed next.

---

* For description of test methods see Federal Register, Vol. 36, No. 247, December 23, 1971.

Emission Data

Table 1 presents emission data obtained from the tests. Emissions rates are identified separately for total grease, total nonsoluble solids and total soluble solids. The sum total of these is the total particulate emission rate which is also presented for each test run. Table 2 presents these data in summary form and also includes emission rates as pound particulate per pound of product. Complete run data from the tests are available in the form of computer printouts. They are too bulky to be included in this report and can be furnished upon request.

From the test data it is obvious that the highest grain loading is observed during lunch when hamburgers are processed and the lowest grain loading is observed during slack time.

Visual observations of stack opacities were made periodically. The visual emissions were gray-white when present. No observations could be made during the supper (steak) test due to darkness. Emissions during the afternoon (slack) test ran 0-10% opacity with one period of 20-30% opacity. This high period coincided with a period in which the grill was being sprinkled and the charcoal adjusted. Entrained water in the exhaust may be interferring with accurate opacity observations. Emissions during the lunch (hamburger) test were fairly constant and were 20-30% opacity. The grill was sprinkled 10 times during this period and new charcoal added twice.

Summary

The particulate grain loadings and pound particulate per pound of product on Table 2 appear to be low in comparison with some industrial source emissions. More complete comparisons will be discussed in detail as part of the Phase II effort.

If you have any questions on any of the items discussed above, please do not hesitate to contact us. After you have reviewed this report and would like us to proceed with Phase II please inform us per the proposal conditions.

Sincerely yours,

MIDWEST RESEARCH INSTITUTE

K. P. Ananth
Senior Environmental Engineer

Approved:

L. J. Shannon

L. J. Shannon, Assistant Director
Physical Sciences Division

TABLE 1

EMISSION DATA

Run	1-S	2-N	3-S	4-N	5-S	6-N
VMSTD, dscf	39.20	52.93	52.89	50.05	53.04	51.98
PMDS	1.24	1.43	0.8	1.86	1.12	1.14
TS, °F	124	118	120	104	131	107
VS, fpm	2,560	2,527	2,654	2,495	2,634	2,559
QS, dscfm	2,231	2,220	2,332	2,229	2,265	2,295
PERI	76	103	98	97	101	98
Total Emissions						
Mass collected, mg	51.69	81.70	20.57	18.38	26.98	37.02
Particulate loading, gr/dscf	0.0203	0.0238	0.0060	0.0057	0.0078	0.0110
Particulate emission rate, lb/hr	0.388	0.452	0.120	0.108	0.152	0.216
Total, lb/hr	0.840		0.228		0.368	
Total Grease						
Mass collected, mg	9.08	12.27	0	0	2.33	2.29
Particulate load, gr/dscf	0.0036	0.0036	0	0	0.0007	0.0007
Particulate emission rate, lb/hr	0.068	0.068	0	0	0.013	0.013
Total, lb/hr	0.136		0		0.026	
Total Solids Nonsoluble						
Mass collected, mg	30.33	52.85	17.80	15.75	20.02	30.20
Particulate load, gr/dscf	0.0119	0.0154	0.0052	0.0048	0.0058	0.0089
Particulate emission rate, lb/hr	0.228	0.293	0.104	0.093	0.113	0.176
Total, lb/hr	0.521		0.197		0.289	
Total Solids Soluble						
Mass collected, mg	12.28	16.58	2.77	2.63	4.63	4.53
Particulate loading, gr/dscf	0.0048	0.0048	0.0008	0.0008	0.0013	0.0013
Particulate emission rate, lb/hr	0.092	0.092	0.016	0.015	0.026	0.026
Total, lb/hr	0.184		0.031		0.052	

TABLE 1 (Concluded)

	1-S	2-N	3-S	4-N	5-S	6-N
Approximate Pounds/hour meat	51		7		41	

Note: Lunch-hamburger Run { 1-S (south duct). 2-N (north duct).

Afternoon-slack { 3-S 4-N

Supper-steak { 5-S 6-N

VMSTD	- Volume of dry gas sampled through dry gas meter at standard conditions.
PMOS	- Percent moisture in stack gas, by volume.
TS	- Stack temperature.
VS	- Stack velocity.
QS	- Volumetric flow rate in stack at standard conditions, dry basis.
PERI	- Percent isokinetic.

TABLE 2

SUMMARY OF EMISSION RATES

Run	Discharge Rate (dscfm)	Moisture (% by Vol)	Total Particulates[b]		lb particulate / lb of product
			(gr/dscf)	(lb/hr)[c]	
1-S	2,231	1.24	0.0203	0.39	
2-N	2,220	1.43	0.0238	0.45	0.02
	4,451	1.33 avg[a]	0.0220 avg[a]	0.84	
3-S	2,332	0.8	0.0060	0.12	
4-N	2,229	1.86	0.0057	0.11	0.03
	4,561	1.32 avg[a]	0.0058 avg[a]	0.23	
5-S	2,265	1.12	0.0078	0.15	
6-N	2,295	1.14	0.0110	0.22	0.01
	4,560	1.13 avg[a]	0.0094 avg[a]	0.37	

---

[a] Volume average of north (N) and south (S) ducts.

[b] Total particulate include: (1) total grease; (2) total nonsoluble solids; and (3) total soluble solids.

[c] Assuming 24-hr day.

REPORT OF TELEPHONE CONVERSATION

DIRECT MEAT FIRING INDUSTRY

DATE: 5/17/77

PERSON CALLED: Mr. Ed Zeman

ORGANIZATION: Anetsberger Brothers

ADDRESS: Anets Drive
Northbrook, Illinois 60062

TEL. NO. 312-272-0770

GCA PERSONNEL: M.B.

SUBJECT MATTER:

I questioned Mr. Zeman about the type of broilers that his company manufactures and about any control equipment that may be suitable. I was told that SECO (Southern Equipment Company) manufactures a scrubber for broilers. I will call them. Mr. Zeman said that he will be at the NRA show in Chicago and I can obtain further information then.

REPORT OF TELEPHONE CONVERSATION
DIRECT MEAT FIRING INDUSTRY

DATE: 5/17/77

PERSON CALLED: Mr. Paul Ross

ORGANIZATION: Wolf Range Co.

ADDRESS: 19600 So. Alameda St.
Compton, California 90221

TEL. NO. 213-639-7955

GCA PERSONNEL: M.B.

SUBJECT MATTER:

I called the Wolf Range Co. to obtain information about the types of broilers they manufacture, who they sell to and the types of control equipment that may be suitable for their equipment. Mr. Ross informed me that they make two types of broilers, a charbroiler and a groove griddle which imports the same flavor and looks of a charbroiler to the meat. It may be a viable alternative to controlling emissions from charbroilers.

They will be at the NRA show in Chicago next week. Mr. William Halliburton (National Sales Manager) and Mr. Mark Zee (President) will be there.

REPORT OF TELEPHONE CONVERSATION
DIRECT MEAT FIRING INDUSTRY

DATE: 5/17/77

PERSON CALLED: Mr. Bernie Stever

ORGANIZATION: SECO Southern Equipment Company

ADDRESS:

St. Louis, Missouri

TEL. NO. 314-352-0442

GCA PERSONNEL: M.B.

SUBJECT MATTER:

SECO manufactures control equipment for broilers used at restaurants. They will be at the NRA show in Chicago where I can obtain further information.

REPORT OF TELEPHONE CONVERSATION
DIRECT MEAT FIRING INDUSTRY

DATE: 5/17/77

PERSON CALLED: Don Olson

ORGANIZATION: South Bend Range

ADDRESS: 211 S. Cherry St.
South Bend, Indiana 46625

TEL. NO. 219-287-6586

GCA PERSONNEL: M.B.

SUBJECT MATTER:

South Bend manufactures three types of broilers for restaurant use. They are:

1. Top-fired gas broilers
2. Radiant broilers
3. Charbroiler with larva rocks.
   Charbroilers are used primarily by small restaurants.

Mr. Olson and Mr. Engeart will be at the NRA show in Chicago.

REPORT OF TELEPHONE CONVERSATION

DIRECT MEAT FIRING INDUSTRY

DATE: 5/17/77

PERSON CALLED: Mr. Daniels

ORGANIZATION: Star Mfg. Co.

ADDRESS: 9325 Olive Boulevard
St. Louis, Missouri 63132

TEL. NO. 314-994-0880

GCA PERSONNEL: M.B.

SUBJECT MATTER:

Their largest charbroiler is a 2-ft. unit. They manufacture both gas and electric units. Mr. Daniels will be at the NRA show in Chicago and should be able to provide me with further information.

REPORT OF TELEPHONE CONVERSATION

DIRECT MEAT FIRING INDUSTRY

DATE: 5/17/77

PERSON CALLED: Mr. Hollis

ORGANIZATION: Magikitchen

ADDRESS: Quackertown, Pennsylvania

TEL. NO. 215-536-8140

GCA PERSONNEL: M.B.

SUBJECT MATTER:

Mr. Hollis told me that the last available data for the charbroil restaurant industry was published by the Food Service Industry in 1966. They stated that 6.6 percent of total restaurants have charcoal broilers, 13.3 percent countertop broilers, and 5.1 percent salamander broilers (sliding drawer).

He mentioned the following restaurants:

Ponderosa

Rustler

Marriott Hotels

Ho Jo's

Open hearths are used at the more expensive restaurants. Mr. Hollis will be at the NRA show in Chicago. The average life of a charbroiler is approximately 10 to 15 years according to Mr. Hollis.

REPORT OF TELEPHONE CONVERSATION

DIRECT MEAT FIRING INDUSTRY

DATE: 5/18/77

PERSON CALLED: Mr. Rubin Palm

ORGANIZATION: Palm Brothers

ADDRESS: Century 21 APC
Minneapolis, Minnesota

TEL. NO. 612-871-2727

GCA PERSONNEL: M.B.

SUBJECT MATTER:

Mr. Palm explained to me about a control device they are marketing called a "Twister-aire-Recycler" used for electric charbroilers. This device uses a grease knockout area which is periodically cleaned with a water wash system. The unit is comprised of a glass filter, an activated carbon bed and a HEPA filter. The gas after it is cleaned, is returned to the ventilation system thus saving on heating and cooling costs. Mr. Palm stated that he will send me further information on the system. He will also be at the NRA show in Chicago.

REPORT OF TELEPHONE CONVERSATION
DIRECT MEAT FIRING INDUSTRY

DATE: 5/18/77

PERSON CALLED: Mr. Brown

ORGANIZATION: American Meat Inst.

ADDRESS: 1600 Wilson Boulevard
Arlington, Virginia 22209

TEL. NO. 703-841-1030

GCA PERSONNEL: M.B.

SUBJECT MATTER:

The AMI was contacted to determine if any statistical information is available concerning the consumption of meats in restaurants. Mr. Brown stated that he knew of only one publication which is rather old; however, it is the only one available. The USDA published in November, 1971 a standard Bulletin No. 476 entitled, "Food Service Industry Type, Quantity and Value of Foods Used."

I will call the USDA to see if there is a latter issue.

REPORT OF TELEPHONE CONVERSATION
DIRECT MEAT FIRING INDUSTRY

DATE: 5/18/77

PERSON CALLED: Mr. James Nix

ORGANIZATION: Economic Research Service USDA

ADDRESS: Washington, D.C.

TEL. NO. 202-447-8972

GCA PERSONNEL: M.B.

SUBJECT MATTER:

Mr. Nix provided me with the following statistical information on meat production and consumption.

Commercial production of beef	25,662,000,000 lbs.
Civilian consumption adjusted for export and import	27,132,000,000 lbs.
Military consumption	246,000,000 lbs.

They estimate that 50 percent is used by the consumer at home.

40 percent by restaurants

10 percent by military, hospitals, schools, institutions

He thought we should contact GRALLA Publishing Co. in N.Y. They publish "Supermarketing." (Journal) Telephone No. (212) 869-1300.

REPORT OF TELEPHONE CONVERSATION
DIRECT MEAT FIRING INDUSTRY

DATE: 5/18/77

PERSON CALLED: GRALLA Publishing

ORGANIZATION: "Supermarketing"

ADDRESS: 1515 Broadway
N.Y., N.Y.

TEL. NO. 212-869-1300

GCA PERSONNEL: M.B.

SUBJECT MATTER:

Their SEPT. 1976 issue discussed the supermarket industry with respect to the restaurant and fast food industry. I requested a copy of the article which they will send.

REPORT OF TELEPHONE CONVERSATION

DIRECT MEAT FIRING INDUSTRY

DATE: 5/18/77

PERSON CALLED: Mr. Drexel T. Carlson

ORGANIZATION: Drexel T. Carlson Co.

ADDRESS: 2909 W. 93rd Terrace
Leanwood, Kansas 66206

TEL. NO. 913-381-3772

GCA PERSONNEL: M.B.

SUBJECT MATTER:

Mr. Carlson has developed a control device for reducing visible emissions at restaurants. The unit is a vapor reactor called an "Airgiene."

The unit has been tested on a small scale of 1,000 cfm at the Hereford Steak House in Kansas City. The Steak House is actually exhausting 5,500 cfm. The opacity readings during the test were 0 to 5 percent.

The cost for a full-size unit for this restaurant would be:

$8,000/design 7,200 cfm unit. Only need 5,500 cfm but external air is used.

Operating costs:
- 15 Hp motor 10 hrs/day electricity
- 1-1/2 to 2 gallon make-up H_2O per hour/1000 cfm wetting agent added to H_2O

REPORT OF TELEPHONE CONVERSATION
DIRECT MEAT FIRING INDUSTRY

DATE: 5/19/77

PERSON CALLED: Mr. George DeLapp

ORGANIZATION: Kansas City Air Quality Office

ADDRESS: 414 E. 12th St.
Kansas City, Missouri

TEL. NO. 816-274-2501

GCA PERSONNEL: M.B.

SUBJECT MATTER:

Kansas City has an extensive program to enforce their opacity and odor regulation on charbroilers and Bar-B-Q pits. Presently, all but ≈ 30 restaurants have either installed control equipment or have made a process change to control their emissions. They are using primarily afterburners with one or two using ESP.

Mr. DeLapp mentioned that he had previously performed a nationwide survey to determine what other agencies are doing to control restaurant emissions. He promised to mail this information sometime during the next several weeks.

Health Department
Air Quality Section 50350

City of Kansas City, Missouri
Heart of America

21st Floor, City Hall
Kansas City, Missouri 64106

816-274-2501

May 20, 1977

Mr. Mark Bornstein
G.C.A. Corporation
Technical Division
Burlington Road
Bedford, Mass. 01730

Re: Information/charbroilers
and barbecues

Dear Mr. Bornstein:

Enclosed is information that you requested regarding control efforts regarding restaurant charbroilers and barbecues.

Kansas City, Missouri at present has some 1100 restaurants operating. In 1971, when this Section began abatement actions on visible emissions from charbroilers and barbecues all restaurants were surveyed by letter.

It is estimated that approximately 10% had charbroilers and/or barbecue pits. The first effort found that no one knew what kind of controls to get, who manufactured adequate controls and what the costs were.

To assist the program 315 enforcement agencies were queried to see what their actions were, if any, 175 answers were received. Their answers are broken down in attached material.

Further 47 air pollution control manufacturing companies were queried, 24 answers were received (enclosed).

Roughly, as of January 1, 1976, 122 restaurant complied with the Visible Emissions Section of the Kansas City, Missouri Air Pollution Control Code, a list is enclosed.

An operation's cost list is also enclosed, but does not include national gas cost increases for 1976 and 1977.

Three more controls are listed on a copy of a letter to the Restaurant Association, these became known after the 47 companies were queried.

Also, as you know, there is another new experimental control, the aire-giene vapor-reactor, that is presently being tested at the Hereford House Restaurant in Kansas City, Missouri.

Lastly, a copy of a report that I received from the Bay area Air Pollution Control District in California is included. The Kansas City, Missouri Air Quality Section's findings concur with this report.

I hope that the information that I have compiled is of assistance to you. If there are any specific questions please contact me.

Sincerely,

George H. De Lapp

George H. De Lapp
Supervisor/Enforcement
Air Quality Section

GHD/pk

Encl.

Health Department
Section 50339

City of Kansas City, Missouri
Heart of America

10th Floor, City Hall
Kansas City, Missouri 64106

May 25, 1976

Mr. Max Kerner, President
Missouri Restaurant Association
4003 Penn
Kansas City, Missouri

Dear Mr. Kerner:

This department, in its continuing search for adequate air pollution controls for industry and for charboilers, has recently learned of two new pieces of such equipment.

Knowing that the Restaurant Association and its members are deeply concerned with reducing the air pollution problem in Kansas City metropolitan area, this information is forwarded to you for dissemination to the membership.

Since the Restaurant Association and its members are also deeply concerned with the energy shortage, the following equipment should interest them.

The Monsanto Enviro-Chem Systems, Inc., 800 North Lindbergh Blvd., St. Louis, Missouri 63166 has recently introduced the Brinks Mist Eliminator, the phone number is 1-314-694-3835.

This device is a filtration device with a water wash that does not use natural gas. It has been installed and is in operation on a Hardee's Restaurant in Maryland.

Maryland State Air Quality Engineer, Wayne Fritz was contacted and he confirmed the above. Marylands Air Pollution Control Regulations require zero Ringelmann and Mr. Fritz said the device was successful.

Food Service and Engineering personnel of Crown Center Corp. are investigating the Brinks System and very possibly will install a unit on the 25 Grand Restaurant in conjunction with a charbroiler operation.

THIS UNIT IS NOW BEING INCORPORATED INTO A SYSTEM NAMED "THE CONQUEROR" & IS PRODUCED & SOLD BY HARDEE'S FOOD ROCKY MOUNT, N.C.

The second air pollution control is a system designed and manufactured by Century 21 Pollution Control, Inc., 5104 Hillsboro Avenue, North, Minneapolis, Minnesota, 55428 telephone 1-612-535-3652.

The unit is the "Twister Airerecycler System" it also uses no natural gas and has a wash down system. The company states that the cleansed air from the charbroiler hood is exhausted back into the room.

If the unit is so installed, it is immediately removed from Air Pollution Control Section's jurisdiction since we are concerned only with emissions to the ambient air.

In any event personnel from Crown Center Corp. traveled to Minneapolis to observe the Airerecycler in operation.

The unit was installed on a charbroiled hamburger operation at a Kiosk in an enclosed shopping mall. Crown Center reports that the unit was observed for a period of 2 hours thru the noon rush. No odor or smoke was observed being emitted from the exhaust.

The exhaust was bented directly into the enclosed mall. The old Pusateri's New Yorker Restuarant and the Jones Store at 12th and Main are considering this unit for installation.

There is also an electric charbroiler called Jenn-air that operates satisfactorily, from the visible emissions angle, and is manufactured by the Jenn-air Corp. and sold by the Heaven Engineering Company, 5011 Antioch, Shawnee Mission, Kansas 66203, Phone 362-5560.

Should any other suitable air pollution control equipment for charbroilers be turned up in our neverending research, you will be notified.

If there are any questions please contact this department.

Sincerely,

George H. De Lapp
Supervisor/Enforcement
Air Quality Section

GHD/pk

0
(1975)

COST OF OPERATIONS FOR AIR POLLUTION CONTROLS AS APPLIED TO BARBECUE PITS, KANSAS CITY, MO.

Establishment	AP Control	Operating cost
Bryants BBQ, 1735 Brooklyn	Afterburner	$273.64-30 day bill May-June
Natural gas use includes 2-1,000,000 Btu afterburners in AP control, 2-500,000 Btu burners in incinerator, gas cooking stoves, french fryers, steam tables, and hot water supply. Cooks average of 2000# meat per day-total gas cost for June bill prorated back to meat per lb=approximately 4/10 cent per lb.		
Gates BBQ, 1221 Brooklyn	Afterburner	$100.00- Average 30 day bill
Natural gas use includes heating, AP control, cooking, hot water and steam table.		
Gates BBQ, 1411 E Swope Parkway -	Afterburner	$150.00-Average 30 day bill
Natural gas use includes heating, AP control, cooking, and hot water. AP control is 1,000,000 Btu afterburner.		
Oscar's BBQ, 6201 E Blue Parkway-	Afterburner	$70.00-Average 30 day bill
Cost for 250,000 Btu afterburner only.		
Smokestack BBQ #1, 8129 S 71 Hiway-	Afterburner	$125.00-Average 30 day bill
Natural gas use includes 2-AP controls, afterburners, hot water and french fryers.		

COST OF OPERATIONS FOR AIR POLLUTION CONTROLS AS APPLIED TO CHARBROILERS, KANSAS CITY, MISSOURI

Establishment	AP Control	Operating cost
Hardee's, 5322 Troost	Afterburner	$80.00 per month average
102nd & Wornall	Afterburner	75.00
2825 NE Vivion Road	Afterburner	75.00
Hardee's costs are for natural gas for afterburners, only.		
Cork & Cleaver, 103 & State Line	Afterburner	$167.71-30 day bill May-June
Natural gas use includes 3 gas fired fireplaces that are in use at all times for effect, a 24" x 36" charbroiler, a 6-burner gas stove, and a hot water supply.		
Ramada Inn, 6105 E 87th Street	Afterburner	$900.00-30 day bill April-May
Natural gas use for complete hotel heating, hot water, charbroiler, cooking, and AP control afterburner.		
Snooty Fox, Linwood & Gillham	Afterburner	$151.69-30 day bill May-June
Natural gas use includes AP control, charbroiler, hot water supply, and other cooking. Exhaust hood emits 1500 cfm of effluent, 500,000 Btu--afterburner setting.		

122 RESTAURANTS THAT HAVE COMPLIED WITH THE AIR POLLUTION CONTROL CODES VISUAL EMISSIONS SECTION BY ONE MEANS OR ANOTHER

SERRATED GRILL	DATE COMPLIED
International House of Pancakes, 5171 Chouteau	12-6-74
International House of Pancakes, 6501 Troost	3-20-73
International House of Pancakes, 3620 Broadway	3-6-75
Annie's Santa Fe Restaurant, 100 W. Ward Parkway	3-28-73
Alameda Plaza Hotel,Wornall at Ward Parkway (All charbroilers removed from plans)	May, 1972
Harold's Place, 3071 N.E. Prather	5-21-73
Inner Circle Continental Hotel, 106 West 11th	10-11-74
Houlihans Old Place, 4743 Penn	3-2-73
Runway Restaurant, 250 Richards Road	12-9-73
Sambo's, 3145 Gillham	6-15-73
Sambo's Restaurant, Bannister and Troost	11-16-72
Sambo's Restaurant, Eastwood Drive & I 435	equip. in plans
Sambo's Restaurant, Blue Ridge Blvd.	equip. in plans
Santa Fe Inn, 6600 Blue Ridge	2-26-74
Sizzler Family Steak House, 3205 Main	5-14-73
Sizzler Family Steak House, 2628 N.e. Vivion	5-14-73
Stix, Baer & Fuller, 8800 Ward Parkway	2-2-73
Stix, Baer & Fuller Coffee Shop, 8800 Ward Parkway	2-2-73
Romanelli's Bar, 7122 Wornall	3-6-75
Denny's, 1600 Broadway	10-26-72
Denny's, 3910 Main	11-13-72
Fun Spot, 2934 Southwest Blvd.	4-9-75
Little Angus Grill, 4181 Broadway	3-7-75
Penn Valley Community College, 3201 Southwest Trafficway	4-23-73
Vineyard, 900 Broadway	6-27-73
Crown Center Hotel Shops, Grand and Pershing (All charbroilers removed from plans)	4-23-72
Old San Francisco, 1617 Genessee	2-26-74
Velvet Freeze, 7120 Prospect	8-20-75
Velvet Freeze, 5536 N.E. Antioch Road	8-20-85
Velvet Freeze, 5400 N.W. 45 Highway	8-20-75
Velvet Freeze, 8220 Bannister Road	8-20-75
OVERFIRED BROILER	
Crown Center Hotel & Shops, Grand & Pershing (All charbroilers removed from plans)	4-23-73
International House of Pancakes, 7640 Wornall	6-26-72
The Depot, 72nd and Wornall (All charbroilers removed from plans)	10-23-73
Eddy's, 1301 West 103rd	2-2-73
El Chico, 8600 Ward Parkway	2-2-73
Embers, 8250 South 71 (All charbroilers removed from plans)	4-16-74
Holiday Inn, Plaza Circle, K.C.I. (All charbroilers removed from plans)	3-8-73
Holiday Inn, Blue Ridge Cut-off & I 70 (All charbroilers removed from plans)	8-5-74
Holiday Inn, Parvin Road & I 435 (All charbroilers removed from plans)	1-6-75

OVERFIRED BROILER cont.

K.C. Chiefs Arrowhead Inn, Sport Complex	2-6-75
K.C. Chiefs Stadium Club, Sports Complex	3-26-73
K.C. Royals Stadium Club, Sports Complex	4-9-73
G Lindsey's, 78th and Wornall	10-18-73
Marriot Hotel, K.C.I.	8-5-74
Marriot In Flight Food Service, K.C.I.	11-14-72
Plaza International, 112 & I 29	6-24-74
Ramada Inn, Tiffany Springs & I 29	3-26-74
Rodeway Inn, 11420 Hickman Mills	6-18-73
Royal Inn, 11828 Plaza Circle	2-7-73
Sheraton Royal Hotel, 9103 East 39th	5-9-74
Waldo Astoria Theatre, 7428 Washington	8-6-73
Breckenridge Inn, I 435 & Front	equip. in plans
Sirloin Stockade, 11828 Blue Ridge	9-5-72
Voyager Restaurant (Travel Lodge),921 Cherry	6-25-73
Mama Angelines, 400 Wyandotte	9-3-74
Tasty World, I 35 & N.E. Antioch	11-21-74
Victoria Station, 3rd & Delaware	4-1-74
Village Gate, 410 Delaware	11-27-74
Buttonwood Tree, 4900 Main	8-22-75
Hotel Muehlebach, 12th & Baltimore	plans approved 8-19-75

FLAT GRILL

Ebanezers, 309 Delaware	11-21-72
Nicky's, 928 Wyandotte	3-6-75

AFTERBURNER

A & H Barbecue, 3107 Swope Parkway	9-4-74
Benny's Inter City Barbecue, 8509 Winner Road	4-2-75
Arthur Bryants Barbecue, 1727 Brooklyn	6-2-72
City Market Smoke House Barbecue, 20 East 5th	5-21-73
De Lux Famous Barbecue, 2912 Brooklyn	11-27-74
Gates Barbecue, 1411 East Swope Parkway	6-11-73
Gates Barbecue, 1221 Brooklyn	8-21-72
Harris Barbecue, 2401 Brooklyn	10-30-73
J.B. & Sons Barbecue, 5429 Troost	7-30-75
J.B.s Barbecue, 3325 East 31st	11-20-74
Oscars Barbecue, 620 East U.S. 50	11-22-72
Sherman's Better Barbecue, 5900 Prospect	7-13-73
Smoke Stack #1, 8129 South U.S. 71	5-14-73
Smoke Stack #2, 135 & Wornall	7-9-74
Sammy's Barbecue, 7100 Troost	(Installed, operating permit not yet issued)
Cork & Cleaver, 103rd and State Line	4-9-73
Fire Side Inn, 5500 N.E. Antioch Road	7-1-74
Golden Ox Restaurant, 1600 Genessee	12-11-74
Hardee's, 2825 N.E. Vivion	2-27-74
Hardee's, 102nd and Wornall	7-10-73
Hardee's, 5322 Troost	9-7-73
Ramada Inn, 6101 East 87th	5-25-73
ooty Fox, 3150 Gillham	6-11-73
Boyds Barbecue, 5510 Prospect	8-6-75
Ray's #2 Barbecue, 2600 Gregory Installation permit issued 7-30-75, installed, not yet fully connected	

E.S.P.

Howard Johnson, 1602 Russell Road	1-29-74
Victoria Station, 3rd and Delaware	4-1-74

F TER

Jake Edwards, 5107 Main	8-13-71
T.W.A. In Flight Food Servic, K.C.I.	1-3-74

TEMP. CONTROL & UNDERGROUND EXHAUST

Dairy Queen, 414 East 63rd	7-10-75
Dairy Queen, 7801 N.W. Prairie View	10-7-74
Dairy Queen, 4343 N. Cleveland	6-11-73
Dairy Queen, 4901 Hardesty	9-26-73
Dairy Queen, 649 Bannister	3-25-75
Dairy Queen, 434 West 85th	4-25-74

TEMP. CONTROL

Wishbone Restaurant, 4455 Main	6-27-73
Sears Roebuck, 15th & Cleveland 4-30-74 Construction permit issued, visible emissions O.K. but company still trying to develop automatic temp. controls.	

GAS ONLY

Long's Barbecue, 6311 Prospect	5-28-73
Oven Barbecue, 1501 East 17th Terrace	2-11-72
ittle Pigs Barbecue, 501 Wyandotte	2-12-75
Gladys House of Ribs, 3842 Prospect	8-29-75
Rib Cage Restaurant & Barbecue, 7006 N.W. Barry Road	5-14-71

USE CEASED

Crimson Coach Lounge, 8910 East 40	4-8-74
Nino's Place, 1321 Admiral	10-31-72
Olympic Flame, 8241 Wornall	6-5-75
Branding Iron, 5000 East Linwood	10-9-72
Capri Motel, Independence & Paseo	10-9-72
Black Angus, 6015 Troost	4-9-75
Mike's Bar, 5424 Troost	6-1-73
Papa Nicks, 418 Delaware	10-24-74
Papillon Barbecue, 7200 Wornall	7-9-74
Patio Annex, 321 East 11th	6-13-74
Poor Freddies, 301 Delaware	10-24-73
Gunthers Fine Foods, 8510 East New 40	3-6-75
Jade East, 200 East 12th	3-6-75
Menorah Hospital Restaurant, 4949 Rockhill Road	2-1-73

PROCESS CHANGE

Burger Chef, 6800 Bannister	10-27-72
Halls Chestnut Farms Restaurant, 5050 Oak	8-6-75
rtys Barbecue, 214 West 85th	7-22-74
Stephensons, U.S. 40 & Lees Summit Road	12-21-70

REPORT OF TELEPHONE CONVERSATION
DIRECT MEAT FIRING INDUSTRY

DATE: 5/19/77

PERSON CALLED: Mr. Frey and Mr. Joe Crawford

ORGANIZATION: FC Industries

ADDRESS: Overland Park
Kansas

TEL. NO. 913-381-5005

GCA PERSONNEL: ____________

SUBJECT MATTER:

FC Industries sells afterburners for the restaurant industry. Afterburners are about the only thing that can be put on Bar-B-Q's because they do not need a fan to induce the draft. Bar-B-Q's work better if they use a natural draft. Afterburners and ESP are OK for charbroilers not for Bar-B-Q's.

A typical Hardees with a 2,000 cfm unit and a temperature rise of 300°F will need 600,000 Btu/hr at $1.70/1,000 CFM for natural gas. or $1.02/hr. for gas. The unit will most likely only be used for 5 to 6 hrs. per day during busy periods. So at $6/day x 365 = $2,250/year for natural gas. Mr. Crawford suggested I contact United Air Specialists in Cinn. Ohio to obtain data about "Smoke Eaters" and ESP.

REPORT OF TELEPHONE CONVERSATION
DIRECT MEAT FIRING INDUSTRY

DATE: 5/20/77

PERSON CALLED: Mr. Dan Christman

ORGANIZATION: United Air Specialist

ADDRESS: Cincinnati, Ohio

TEL. NO. 513-891-0400

GCA PERSONNEL: M.B.

SUBJECT MATTER:

UAS Manufactures an ESP for restaurants called the "Smoke Eater." Dave provided me with industries estimate of the number of restaurants in the country and the number of direct fired restaurants. There are 500,000 total restaurants of which 7 to 10 percent direct fire resulting in 35 to 50,000 across the country. The most recent annual growth rate for the industry is 12 percent.

Dave will be at the Chicago show so that we can discuss the industry in further detail.

REPORT OF TELEPHONE CONVERSATION
DIRECT MEAT FIRING INDUSTRY

DATE: 5/25/77

PERSON CALLED: Mr. Vince Vino

ORGANIZATION: Gas Appliance Manufacturers Association (GAMA)

ADDRESS: Virginia

TEL. NO. 703-525-9565

GCA PERSONNEL: M.B.

SUBJECT MATTER:

I called GAMA to determine if their organization had any information on the number of gas-fired units used by the restaurant industry. There is presently no information of this nature available through this organization.

State of Maryland

DEPARTMENT OF HEALTH AND MENTAL HYGIENE
ENVIRONMENTAL HEALTH ADMINISTRATION
P.O. BOX 13387
201 WEST PRESTON STREET
BALTIMORE, MARYLAND 21203
PHONE • 301-383-3147/3148/3149

NEIL SOLOMON, M.D., PH.D.
SECRETARY

DONALD H. NOREN
DIRECTOR

May 27, 1977

Mr. Mark Bornstein
Environmental Engineering
  Department
GCA/Technology Division
Burlington Road
Bedford, Massachusetts 01730

Dear Mr. Bornstein:

This is in response to your recent letter requesting a copy of our report entitled "Control of Air Pollution from Restaurant Charbroilers".

Unfortunately, the report prepared by the Bureau of Air Quality and Noise Control will not be in its final form and ready for publication until late in June. In the meantime, the manuscript has been scheduled for publication in the July issue of Air Pollution Control Association journal.

I'll have a copy of the report sent to you as soon as it becomes available.

Sincerely yours,

Jim Francis

Jim Francis
Public Health Engineer
Division of Engineering
Bureau of Air Quality
  and Noise Control

JF:bw

SECO

SECO PRODUCTS
McGraw-Edison Company

4560 Gustine Ave., P.O. Box 7116, St. Louis, Mo. 63177 Phone (314) 352-0442

June 1, 1977

Mr. Mark Bornstein
Environmental Engineering Department
Pollution Control Laboratory
% GCA/Technology Division
Burlington Road
Bedford, Massachusetts 01730

Dear Mr. Bornstein:

Thank you for stopping by our booth at the N.R.A. Show last week. It is always a pleasure to talk to someone about pollution and ventilation as it applies to the Food Service Industry.

At the Show you wanted to know who was working in the field of pollution with regards to our industry. A Dr. Tom Lawrence of the Arthur B. Little Company (AC-617-864-5770) has an ERDA Grant for researching energy savings with regards to cooking in commercial kitchens.

With regards to odor control we have been working with Purafil, Inc. which is a subsidiary of H.E. Burroughs & Assoc. Inc. Their address is: P.O. Box 80434, Chamblee, Georgia 30336, phone AC-404-451-7146.

If we can be of any additional assistance to you in your study please feel free to contact us.

Sincerely,

SECO VENTILATION DIVISION
McGraw-Edison Company

Bernard G. Stever,
Director of Engineering

BGS/lvh

REPORT OF TELEPHONE CONVERSATION
DIRECT MEAT FIRING INDUSTRY

DATE: 6/8/77

PERSON CALLED: Mr. Bob McFee

ORGANIZATION: Lester B. Knight Co.

ADDRESS: Chicago

TEL. NO. 312-346-2100

GCA PERSONNEL: M.B.

SUBJECT MATTER:

Bob McFee has been hired by the Electro Air Company to determine the marketability of their ESP. There is a good chance that Bob and I may be able to exchange some of the information that each of us is obtaining in our contracts. Bob may be able to stop by the office so that we can meet and discuss the likelihood of any exchange.

REPORT OF TELEPHONE CONVERSATION
DIRECT MEAT FIRING INDUSTRY

DATE: 6/10/77

PERSON CALLED: Mr. Cliff Culpepper, President

ORGANIZATION: Aero-Dyne

ADDRESS: Charlotte, North Carolina

TEL. NO. 704-525-8647

GCA PERSONNEL: M.B.

SUBJECT MATTER: Afterburners

Mr. Culpepper has been in the business of manufacturing afterburners and control devices for restaurants for the past 10 years. He is very knowledgeable about the subject and should be a good source of information. I suggest that when we meet at Hardee's in Rocky Mount we also visit Aero-Dyne.

REPORT OF TELEPHONE CONVERSATION

DIRECT MEAT FIRING INDUSTRY

DATE: 6/10/77

PERSON CALLED: Mr. Jeff Haron

ORGANIZATION: Trion Inc.

ADDRESS: Sanford, North Carolina

TEL. NO. 919-775-2201

GCA PERSONNEL:

SUBJECT MATTER:

Trion manufactures ESP which can be used for restaurants. Their main problem with the equipment is getting the Manager of the restaurant to clean the unit at the end of each day. Jeff said he is going to be in the N.Y. area shortly and would like to come by and discuss their process and our contract.

REPORT OF TELEPHONE CONVERSATION
DIRECT MEAT FIRING INDUSTRY

DATE: 6/15/77

PERSON CALLED: Mr. Elliot Laffer

ORGANIZATION: American Air Filter

ADDRESS: 395 Totten Pond Road
Waltham, Mass.

TEL. NO. 617-890-7220

GCA PERSONNEL: M.B.

SUBJECT MATTER:

American Air Filter manufactures a device called a Roto-clone which can be used in restaurants. A typical cost for a 4,000 CFM unit with a 4-inch pressure drop is approximately $5,300 to $5,400. This unit requires a 7.5 H.P. motor and 2.5 gallons per minute of water at 50 psig. Mr. Laffer will send me further data through the mail.

REPORT OF TELEPHONE CONVERSATION
DIRECT MEAT FIRING INDUSTRY

DATE: 6/15/77

PERSON CALLED: Mr. Tom Adams

ORGANIZATION: Gaylord Industries

ADDRESS: Lake Oswego, Oregon

TEL. NO. 503-639-7686

GCA PERSONNEL: M.B.

SUBJECT MATTER:

Gaylord manufactures grease extractors which are 95 percent efficient; however, they will not by themselves meet any opacity regulations. They also manufacture ESP's which are also supposed to be 95 percent efficient and should reduce the opacity to 5 percent. The estimated costs of this equipment is given below:

		Capital cost	Operating cost
Hood-mounted	1500 CFM	\$5,500	
	3000 CFM	\$9,000	\$150/year = \$20 electricity \$130 H_2O + detergent
Roof-mounted	1600 - 2400 CFM	\$6,600	
	2400 - 3600	\$7,700	
	3600 - 4800	\$8,700	
	4800 - 6000	\$9,200	

Avg. length of hood sold 16 feet or 4000 CFM 250 ft^3/linear foot; Lifetime of unit 20 to 30 years.

They also have a plant in Newark, N.J. - Gaylord East Corp.

Mr. Vince Antoniello, Telephone No. #201-242-1610.

75 percent of all new restaurants have charbroilers.
50 percent of new restaurants have gas-fired units.
20 to 25 percent have electric units.
1 percent have charcoal-fired units.

REPORT OF TELEPHONE CONVERSATION
DIRECT MEAT FIRING INDUSTRY

DATE: 6/14/77

PERSON CALLED: Sandy Boyle

ORGANIZATION: Tepco, Inc.

ADDRESS: Garland, Texas

TEL. NO. 214-276-0591

GCA PERSONNEL: PM^{c}

SUBJECT MATTER: Precipitators

Sandy Boyle suggested we call Tepco's East Coast representative:

Thomas Ralph Jr.
15 Pearl Street
Salem, Mass. 01970

617-744-2926

Mr. Ralph stated that he knew of one test in N.Y. and will send the test data.

State of New Jersey
DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF ENVIRONMENTAL QUALITY
JOHN FITCH PLAZA, P. O. BOX 1390, TRENTON, N. J. 08625

February 2, 1972

609 292 5383
6716

Mr. William J. Karas
Vice President
Jamestown Foods, Inc.
t/a Huck Finn Burger Pit
1085 Route #22
Mountainside, New Jersey 07002

Reference: Certificate No. CT-3552
Expiration Date - January 26, 1977
Permit No. P-4410

Dear Mr. Karas:

Enclosed is your approved "Certificate to Operate Control Apparatus or Equipment." The possession of the said certificate does not relieve you from the obligation of complying with all other provisions of the New Jersey Air Pollution Control Code.

Very truly yours,

John D. Bowe
Supervisor, Permits & Certificates
Bureau of Air Pollution Control

JDB:baa

Encl.

cc: Board of Health - Mountainside
Field Office - Metro

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NEW JERSEY STATE DEPARTMENT OF ENVIRONMENTAL PROTECTION

APPLICATION FOR CERTIFICATE TO OPERATE CONTROL APPARATUS OR EQUIPMENT

TO: New Jersey State Department of Environmental Protection
Bureau of Air Pollution Control
P. O. Box 1390
Trenton, New Jersey 08625

Date Jan. 6,1971

Use Instructions, Air-D-14

Sec. A

1. Reference Permit No. ______ SIC No. 4983-7650-00
2. Full Business Name Jamestown Foods Inc t/a/ Huck Finn Burger
3. Address of equipment and/or control apparatus:
   1085 Route 22 Mountainside N.J. (Municipality) Union (County)
4. Location on premises (Bldg., Dept., area, etc.) Only building

Sec. B

1. Identify process equipment Charcoal Brazier
2. List air pollution control apparatus Electronic Precipitator TEPCO
3. Date equipment to be put in use 3/25/71

Sec. C

Plant Contact:

William J. Karas	201-233-7333
Name (Print or Type)	*Telephone No.*
V.P.	none
Title	*Telephone Extension*

This application is submitted in accordance with the provisions of N.J.S.A. 26:2C-9.2, and to the best of my knowledge and belief is true and correct.

William Karas
Signature — all copies

1085 Route #22
Mountainside, N.J. (07092)
Mailing Address, Zip

William J. Karas
Name (Print or Type)
V.P.
Title

DO NOT WRITE BELOW

CERTIFICATE TO OPERATE CONTROL APPARATUS OR EQUIPMENT

TEMPORARY DURATION	5 YEAR DURATION
Certificate No. ______	Certificate No. C-3552
Date Approved ______	Date Approved 1-24-72
Expiration date ______	Expiration date 1-20-77
Approved by: John D Bowe *Supervisor, Permits & Certificates*	Approved by: John D Bowe *Supervisor, Permits & Certificates*

M6042

Submit original and seven (7) copies

Health Department
Air Quality Section 50350

June 30, 1977

City of Kansas City, Missouri
Heart of America

21st Floor, City Hall
Kansas City, Missouri 64106

816-274-2501

Mr. Mark Bornstein
GCA Technology
Burlington Road
Bedford, Mass. 01730

Dear Mr. Bornstein:

In response to your telephone request for charbroiler information I researched our Air Quality Section files and compiled the attached list.

The listed restaurants, in lieu of installing air pollution controls on gas underfired charbroilers, chose to change their mode of cooking steaks and hamburgers.

The equipment listed has been found to be able to broil steaks and hamburgers satisfactorily without emitting visible emissions that are in violation of the Kansas City, Missouri Air Pollution Control Code.

All installers and/or users of this equipment are cautioned that permission to install doesn't give them permission to pollute. If at some time in the future, for what ever reason, an accepted unit was found in Code violation it would be dealt with accordingly. To date, there has not been any such instance.

The attached list of restaurants is comprised of existing restaurants that chose to change their mode of broiling and new restaurants that decided on a mode of broiling other than gas underfired charbroiling.

The balance of the gas underfired charbroilers in Kansas City, Missouri have had air pollution controls of some type installed to reduce visible emissions to within Code parameters.

The exception to the above is a small group of some 20 odd restaurants that have a temporary injunction. This should be resolved within the next 90 days.

If you are able to travel to Kansas City, Missouri in your compilation of facts for EPA, please stop in our office.

Sincerely,

George H De Lapp

George H. De Lapp
Supervisor/Enforcement
Air Quality Section

GHD/pk
Attachment

WOLF SERRATED GRILL
(Grooved griddle)

Vineyard Restaurant
Brothers Mustache Restaurant
Annies Santa Fe Restaurant
Continental Hotel
All Crown Center Restaurants
Houlihan Old Place
International House of Pancakes
(3620 Broadway, 5171 Chouteau, 6501 Troost)
Old San Francisco Restaurant
Rodeway Inn
Rommonelli's Grill
Runway Restaurant
All Sambo's Restaurants
Santa Fe Inn
Sizzler Steak House (2)
Stix, Baer & Fuller
Tasty World Restaurant
Howard Johnson's (Russell Road and I-29)
Little Angus Grill
Penn Valley Community College

SOUTH BEND INFRA RED OVERFIRED BROILERS

Walter Mitty's Restaurant
American Restaurant
Buttonwood Tree
Eddy's, South
El Chico (8600 Ward Parkway)
Holiday Inn (Blue Ridge and I-70)
International House of Pancakes (7640 Wornall)
Pasta, Inc.
Royal Inn, KCI
Rusty Scupper Restaurant
Sheraton Royal (9103 East 39th)
Waldo Astoria
Victoria Station

INFRA RED OVERFIRED UNKNOWN MAKE

Breckenridge Inn
Harolds Place
Holiday Inn,KCI
Howard Johnson, KCI
Marriott Hotel, KCI
Hilton Plaza, KCI

BROASTER-ARISTO MODEL 70 GAS OVERFIRED BROILER

Big John's Restaurant
IlPagliacci House of Pasta

L S LANG QUARTZ COMBO OVER AND UNDER FIRED ELECTRICAL GRILL

Gilbert-Robinson Restaurants (3) KCI
The Depot Restaurant
Arrowhead Stadium (2)
Royals Stadium

VULCAN SUNGLOW OVERFIRED INFRA RED BROILER

Holiday Inn (Parvin Road & I-435)
Marriott In Flight Food Service, KCI
Voyager Restaurant
Ramada Inn (7315 Tiffany Springs Road)

* KCI--Kansas City International Airport

REPORT OF TELEPHONE CONVERSATION
DIRECT MEAT FIRING INDUSTRY

DATE: 6/14/77

PERSON CALLED: Roddy Street

ORGANIZATION: Commercial Fabrication and Machnne Co.

ADDRESS: Mt. Airy, North Carolina

TEL. NO. 919-786-8374

GCA PERSONNEL: PM^{c}

SUBJECT MATTER:

CF&M manufactured a scrubber-afterburner combination for Hardees (2) and for a barbecue center in North Carolina. They are sending drawings. There was no stack testing but the Hardees units did pass visible emissions tests. The unit required 400,000 Btu/hr (from natural gas) and 10 gpm of water. Unit cost was $4 to $5,000. The scrubber alone was sufficient to meet 20 percent opacity standards if the water supply was adequate. (Most restaurants have only 1/2" to 3/4" piping and the unit requires 1".) Hardees dropped these units when they bagan making their own. Hardees was also reluctant to use the amount of natural gas required.

REPORT OF TELEPHONE CONVERSATION
DIRECT MEAT FIRING INDUSTRY

DATE: 6/14/77

PERSON CALLED: Steve Plageman

ORGANIZATION: Ransome Gas Industries

ADDRESS: San Leandro, California

TEL. NO. 415-352-3751

GCA PERSONNEL: PM^c

SUBJECT MATTER: Flue Gas Ecologizer

Steve Plageman says that Ransome does make an afterburner, but as far as he knows the only application has been for industrial incinerators. Another salesman will call back with more information.

REPORT OF TELEPHONE CONVERSATION
DIRECT MEAT FIRING INDUSTRY

DATE: 6/14/77

PERSON CALLED: ____________________

ORGANIZATION: Granco Equipment Division

ADDRESS: Grand Rapids, Michigan

____

TEL. NO. 616-241-5603

GCA PERSONNEL: PM^c

SUBJECT MATTER:

Granco does make industrial afterburners. They did consider restaurant applications a few years ago, but the project never got on paper.

REPORT OF TELEPHONE CONVERSATION
DIRECT MEAT FIRING INDUSTRY

DATE: 6/14/77

PERSON CALLED: __________

ORGANIZATION: Acro-Metal Products

ADDRESS: Minneapolis, Minnesota

TEL. NO. 612-338-7543

GCA PERSONNEL: PM^c

SUBJECT MATTER:

Acro-Metal manufactures make-up air and heat recovery systems. They formerly made an afterburner but no longer.

REPORT OF TELEPHONE CONVERSATION
DIRECT MEAT FIRING INDUSTRY

DATE: 6/15/77

PERSON CALLED: Robert Wieken

ORGANIZATION: Pollution Abatement

ADDRESS: St. Paul, Minnesota

TEL. NO. 612-488-6608

GCA PERSONNEL: PMC

SUBJECT MATTER:

Pollution Abatement manufactures an afterburner which they are trying to combine in a package with a heat exchanger. Wieken will send brochure, specs, and test results.

Nothing used on charbroilers currently.

REPORT OF TELEPHONE CONVERSATION
DIRECT MEAT FIRING INDUSTRY

DATE: 6/15/77

PERSON CALLED: Charles Gorman

ORGANIZATION: Ransome Gas Industries

ADDRESS: San Leandro, California

TEL. NO. 415-352-3751

GCA PERSONNEL: PM^c

SUBJECT MATTER:

Ransome has made "2 or 3" afterburners for restaurants. Their most successful was for a restaurant in Portland, Oregon, but all units were different in design. No specs are available. Ransome quit the business because local jurisdications had so many different standards, but they still have the capability to make these units. The Portland unit cost about $6000 and worked very well - no visible emissions. Gorman will send a chart he developed for calculating retention time, etc. He says the key to success with afterburners is the proper balance of time, temperature, and turbulence.

REPORT OF TELEPHONE CONVERSATION

DIRECT MEAT FIRING INDUSTRY

DATE: 6/16/77

PERSON CALLED: Mr. Ohle

ORGANIZATION: Ohle-Aire Company

ADDRESS: Norwalk, California

TEL. NO. 213-921-5212

GCA PERSONNEL: PMC

SUBJECT MATTER:

Ohle has been in the business for about 10 years. He supplies ESP units to Pinnacle Peak Restaurants, which use mesquite wood. They have operated two units for 6 years, six others for 5 years, with no problems. Opacity readings are 2 to 4 percent. Testing has been conducted by LA and San Bernardino Counties and the City of Tucson among others. Ohle is sending test results and specs. Units are patented in Canada and UK, pending in U.S. and Japan. Ohle feels the sales potential is tremendous if local jurisidictions push the regulations.

REPORT OF TELEPHONE CONVERSATION
DIRECT MEAT FIRING INDUSTRY

DATE: 6/16/77

PERSON CALLED: George Westall

ORGANIZATION: Sears Westall

ADDRESS: St. Louis, Missouri

TEL. NO. 314-645-7890

GCA PERSONNEL: PM^{c}

SUBJECT MATTER:

George Westall has been in the business for 20 years, starting with his neighbor's Bar-B-Q pit, which was his "first professional failure." He makes afterburner units that use raw gas for natural draft systems only. He says forced air systems bend the flames back and reduce efficiency. His unit achieves 90 to 95 percent odor control and no visible emissions. Temperature range is 600° to 700°. The amount of heat added by the burner depends on the process - 3 to 400° for a closed pit barbecue, 450° + for a charbroiler. The units are capable of achieving 1000° because some regulations require this. He says the secret to successful control is reducing the volume of air by using the minimum hood required and lowering it as much as codes allow. He saw a unit at 2 feet in Birmingham. He says that his unit also makes less noise because the flame stands at high velocities (4000 fpm) and hence, turbulent mixing for flame contact isn't necessary. Other afterburner makers don't understand capture velocities. He says that precipitators work OK with clean oil emissions, but that a Westinghouse study showed they don't handle charred fat well. He also says that in his experience closed pit barbecues are the worst control problem and charbroilers are relatively minor. He has sold "a lot" of units, including some to Hardees and two barbecue units in the last week. He says he hasn't pushed the product because regs are not uniform and aren't pushed nationwide.

REPORT OF TELEPHONE CONVERSATION

DIRECT MEAT FIRING INDUSTRY

DATE: 6/14/77

PERSON CALLED: Jim Craig

ORGANIZATION: Craig Industries

ADDRESS: Donners Grove, Illinois

TEL. NO. 312-852-0300

GCA PERSONNEL: PM^{C}

SUBJECT MATTER:

Craig Industries makes ESP's and ESP-scrubber combinations, with some restaurant applications. They are sending answers to as many of our questions as possible.

REPORT OF TELEPHONE CONVERSATION
DIRECT MEAT FIRING INDUSTRY

DATE: 6/14/77

PERSON CALLED: Chris Fink

ORGANIZATION: Honeywell, Inc.

ADDRESS: Kansas City, Missouri

TEL. NO. 816-358-4200

GCA PERSONNEL: PMC

SUBJECT MATTER:

I spoke to Chris Fink's assistant, who promised to send a brochure and specs. on the F-54-C, which is Honeywell's restaurant model precipitator. (Honeywell also supplies control components to American Environmental and other control manufacturers.) She also suggested that we call Tom Maxwell (612-870-2231) or Fred Gabriel (612-870-2253) in Minneapolis, as they handle national marketing of this unit.

REPORT OF TELEPHONE CONVERSATION
DIRECT MEAT FIRING INDUSTRY

DATE: 6/14/77

PERSON CALLED: Tom Maxwell

ORGANIZATION: Honeywell, Inc.

ADDRESS: Minneapolis, Minnesota

TEL. NO. 612-870-2231

GCA PERSONNEL: PMc

SUBJECT MATTER:

Honeywell does not market a precipitator designed specifically for restaurants for such applications. Maxwell is sending specs for an air cleaner called the Y-504. He estimates the market to be "big" and thinks that Honeywell will enter it in the near future. Maxwell says that Emerson Electro Air and Gaylord Industries are the only control manufacturers he knows of in this area.

REPORT OF TELEPHONE CONVERSATION
DIRECT MEAT FIRING INDUSTRY

DATE: 6/13/77

PERSON CALLED: Dick Murphy

ORGANIZATION: Electro Air Division, Emerson Electric

ADDRESS: North Industrial Park Road
Harrison, Arkansas 72601

TEL. NO. 501-741-3464

GCA PERSONNEL: PM[c]

SUBJECT MATTER:

The Enviro-Clean precipitator. MB contacted a representative of the company in Chicago and he promised to send materials.

REPORT OF TELEPHONE CONVERSATION
DIRECT MEAT FIRING INDUSTRY

DATE: 6/17/77

PERSON CALLED: ____________

ORGANIZATION: Oklahoma City County A.Q.C.D.

ADDRESS: 921 NE 23rd
Oklahoma City Ok. 73105

TEL. NO. (405) 427-8651

GCA PERSONNEL: Sue

SUBJECT MATTER: Regulation not specified to industry, but they must comply with Regulation #7 concerning visual emissions, limitation of 20 percent opacity. (5 min/day allowance for start-up).

Investigations are initiated upon public complaints, only, due to a shortage of personnel.

Most popular control equipment - dry filter which must be cleaned each night.

Some use of electro-static precipatators few afterburners, mainly used by BBQ operations.

REPORT OF TELEPHONE CONVERSATION
DIRECT MEAT FIRING INDUSTRY

DATE: 6/17/77

PERSON CALLED: M. Dyer

ORGANIZATION: St. Louis County APCD

ADDRESS: 801 S. Brentwood
Clayton Mo. 63105

TEL. NO. (314) 7260-1100

GCA PERSONNEL: AHC

SUBJECT MATTER:

Claims to be first agency confronted with need to establish standards for charbroil type operations in 1970. Spoke with various control equipment manufacturers to miniaturize units to be applicable to small restaurant operations. Tests proved afterburners most successfully.

Regulations established for visual emission, 20 percent opacity, and for odors. If cited operation is requested to install control equipment, agency responsible for issue of operating permits for control equipment. New restaurants not required to install controls but will be requested to do so when regulations are violated. It is recommended that these restaurants install equipment during construction for cost and convenience savings.

American Air filter equipment has proven quite expensive to operate. Some operations have tried electrostatic precipitators without success, all have been dismantled.

REPORT OF TELEPHONE CONVERSATION
DIRECT MEAT FIRING INDUSTRY

DATE: 6/17/77

PERSON CALLED: Mr. John Mann

ORGANIZATION: Pima County APCD

ADDRESS: 151 W. Congress
Tuscon Az. 85710

TEL. NO. (602) 792-8686

GCA PERSONNEL: AHC

SUBJECT MATTER: Emissions for commercial establishment limited to 40 percent opacity for 3 min per hour. Measurements greater than 60 percent constitute an immediate violation. Mal-odors crossing property lines may be cited pending inspector surveillance. Regulation requested.

Smaller volume operations (such as Hardee's) favor afterburners.

One large Steak House (30 - 40,000 steaks/mo.) has been cited for violations on more than one occasion. The major portion of its business is between 1700 - 2200 hours. Its grill is fueled by Mesquite wood and emissions are controlled by both an electrostatic precipitator and a scrubber.

REPORT OF TELEPHONE CONVERSATION
DIRECT MEAT FIRING INDUSTRY

DATE: 6/17/77

PERSON CALLED: ____________________

ORGANIZATION: Wayne County APCD

ADDRESS: 1311 E. Jefferson St.
Detroit Mi. 48207

TEL. NO. (313) 224-4650

GCA PERSONNEL: AHC

SUBJECT MATTER: Called to inquire about regulations and enforcement activities. Restaurants must comply with cooking odor requirements and opacity limitations. A opacity measurement of 30 percent for 4 min per 1/2 hour is allowed. Any measurements registering greater than 30 percent constitute a violation. Opacity violations are cited by agency inspectors, while cooking odor annoyances reported by the general public typical/initiate investigations.

In the opinion of the agency's representative, afterburners are the most popular control equipment utilized in the area. One restaurant is known to use a condensor.

Copies of the regulations were requested.

REPORT OF TELEPHONE CONVERSATION
DIRECT MEAT FIRING INDUSTRY

DATE: 6/17/77

PERSON CALLED: ______________________

ORGANIZATION: Western N.C. Region APCA

ADDRESS: 35 Woodfin St.
Asheville, N.C. 28807

TEL. NO. (704) 255-5655

CCA PERSONNEL: AHC

SUBJECT MATTER:

Visual emissions regulations set at 20 percent opacity process weight rate established on a sliding scale (regulations to be forwarded). An incineration system or afterburner most common type of control utilized. One problem that occurs frequently is assuring that the system is operated when required. One chain restaurant was cited as a prize example (Hardee's). One owner installed an electrostatic precipitator without much success. Enforcement of regulations are not considered a major problem in this area.

REPORT OF TELEPHONE CONVERSATION
DIRECT MEAT FIRING INDUSTRY

DATE: 7/15/77

PERSON CALLED: Mr. Jim Francis

ORGANIZATION: Bureau of Air Quality and Noise Control
Maryland State Dept. of Health and Medical Hygiene

ADDRESS: 201 West Preston St.
Baltimore, Maryland 21203

TEL. NO. (301) 383-3147

GCA PERSONNEL: M.B.

SUBJECT MATTER:

I discussed with Mr. Francis his article which was recently published in the "Journal of Air Pollution Control Association." The average size charbroiler used for his study was 3000 cfm. The test data used in his report was provided by Hardee's. Mr. Francis recommended that 800° F be maintained in an afterburner to reduce visible emissions and odors. Apparently, 500° F is sufficient to reduce visible emissions but not odors.

The state agency has the stricest regulation in the country "no visible emissions." Mr. Francis did state however that older restaurants constructed before 1972 are exempt but are only allowed 20 percent opacity. He estimates that 100 charbroilers are registered in the State and an unknown amount not registered.

REPORT OF TELEPHONE CONVERSATION
DIRECT MEAT FIRING INDUSTRY

DATE: 7/15/77

PERSON CALLED: Mr. Larry Stahl
ORGANIZATION: Hardee's
ADDRESS: Rocky Mountain, N.C.

TEL. NO. (919) 977-2000
GCA PERSONNEL:
SUBJECT MATTER:

Mr. Stahl was contacted to obtain further information concerning the "Conqueror." The model 2496 can handle up to 2500 cfm at a cost of $5950. A unit designed to handle 3000 cfm will cost $6500. An average size Gaylord hood will cost an additional $3000. Operating costs are approximately $140/month which includes hot water, caustic cleaner and electricity. Mr. Stahl stated that afterburners are too costly to use since 1400° F must be maintained for proper incineration of the hydrocarbons. In some cases the products of combustion are worse than the uncontrolled emissions. For proper operation of the Conqueror cooling water is added as a spray. ESP have not been properly designed and have not received any approval from the various codes since they are not constructed of the proper material. Their efficiency with continued use will decrease and are only 70 percent efficient below 3 microns. The codes associated with ducting are NFPA - 96 and BOCA section M-30 Building Office and Code Administration.

Mr. Stahl suggested I call Mr. Cane of The Washington Gas and Light Co. concerning the use of afterburners in restaurants. Verification of the proper temperature required may be obtained from him
(703) 750-4235.

Modification and Reconstruction

Reconstruction of a facility takes place but once every 7 years. Usually only the decor is changed not the cooling equipment. Modifications to a restaurant that will increase the emissions could be the changing from a griddle to a charbroiler. Increasing the temperature of the makeup air to the charbroiler will cause an increase in the number of fine particulates and opacity, resulting in a decrease in the efficiency of a control device.

Mr. Stahl stated that for the three test reports, which I received from Mr. Herring, the amount of meat cooked is approximately 100 lbs/per hr. This represents a completely saturated grill.

REPORT OF TELEPHONE CONVERSATION
DIRECT MEAT FIRING INDUSTRY

DATE: 7/15/77

PERSON CALLED: John Cane

ORGANIZATION: Washington Gas and Light Company

ADDRESS: Virginia

TEL. NO. (703) 750-4235

GCA PERSONNEL:

SUBJECT MATTER:

There are no data to substantiate that 1400° F is required in an afterburner for it to properly control a charbroiler at a restaurant. Mr. Cane suggested however that 1400° F would be sufficient to completely combust all the organics in the waste stream.

1-614-012

GCA/TECHNOLOGY DIVISION

16 August 1977

Mr. Edward M. Wiik, P.E.
Director D.A.Q., M.P.C.A.
1935 West County Road, B2
Roseville, MN 55113

Dear Mr. Wiik:

GCA is presently under contract with the U.S. EPA to develop background information for the direct meat firing industry. This information will be used to develop emission factors which will assist in the development of possible new source performance standards for this industry.

In conversation with Mr. Jerry Liefert of the Division of Air Quality, I was informed that the D.A.Q. has performed emission tests at a Hardee's in Rochester, MN, at an Arthur Treacher's in Richfield, MN, and at other direct meat firing restaurants (Bar-B-Q's, charbroilers, open grills) in the state. If possible, I would like to obtain copies of any Emission Test Report that you may have available with regard to such restaurants that use a cooking process where the meat comes in direct contact with the flames.

If there are any problems or if you need further clarification, do not hesitate to call.

Sincerely yours,

Alan Castaline
Alan Castaline

AC:jaf

URLINGTON ROAD, BEDFORD, MASSACHUSETTS 01730 / PHONE: 617-275-9000

Minnesota Pollution Control Agency

612-296-7272

August 24, 1977

Mr. Alan Castaline
GCA/Technology Division
Burlington Road
Bedford, Massachusetts 01730

Dear Mr. Castaline:

In response to your letter dated August 16, 1977 requesting copies of emission tests on direct meat firing sources in Minnesota, I am sorry to inform you that none have been made. Only visual and olfactory observations of such sources were made before and after installation of APC equipment. However, I did discuss this matter with Dr. Milos M. Tomaides, Ph. D., P.E., President of MMT Environmental, Inc. who has definite ideas on how valid particulate and odor emissions test data can be obtained. He would be willing to make such tests for GCA if you are interested and I took the liberty of giving him your letter to Mr. Wiik. Should you desire to contact Dr. Tomaides, his address is 4643 N. Chatsworth Street, St. Paul, MN 55112. His telephone number is (612) 483-0956.

Regarding Arthur Treacher's in Richfield, MN, odor emission tests were made. However, this is a direct deep fat cooking operation, not a direct fired meat facitliy. If you desire a copy of this emission test report, please contact Mr. Greg West, Arthur Treacher, 1328 Duplin Road, Columbus, Ohio 43215.

Sincerely,

Jerry Liefert

JERRY LIEFERT, P.E.
Engineering Section
Division of Air Quality

JL/ck
cc: Dr. Milos Tomaides

1935 West County Road B2, Roseville, Minnesota 55113
Regional Offices • Duluth / Brainerd / Fergus Falls / Marshall / Rochester / Roseville
Equal Opportunity Employer

REPORT OF TELEPHONE CONVERSATION
DIRECT MEAT FIRING INDUSTRY

DATE: 9/22/77

PERSON CALLED: Mr. Bob Galbierz called Mark Bornstein

ORGANIZATION: Monsanto

ADDRESS: St. Louis, Missouri

TEL. NO. (314) 694-2725

GCA PERSONNEL: Mark Bornstein

SUBJECT MATTER:

Monsanto Brink Mist Eliminator.

Bill Herring referred Mr. Galbierz to GCA regarding their Brink Mist Eliminator. Mr. Galbierz is Product Manager for the Mist Eliminator and is looking into the charbroiling market for his control device. There is the possibility that other control equipment vendors other than Hardee's may sell their system.

The efficiency of the Mist Eliminator which will be used in our study will be an overall figure of 93 percent. Mr. Galbierz stated that this is an accurate figure. He also agreed with our estimate of 32,000 direct meat-firing facilities in the county.

The two reports which I received from Hardee's which were marked confidential can be used in our study. Mr. Galbierz will send a letter to release this information. Monsanto originally prepared these two reports.

DEPARTMENT OF HEALTH, WELFARE
& BIO-ENVIRONMENTAL SERVICES
Bio-Environmental Services Division
Air and Water Pollution Control

August 22, 1977

Mr. Alan Castaline
GCA Technical Division
Burlington Road
Bedford, Mass. 01730

Dear Mr. Castaline:

Pursuant to our telephone conversation of August 19, 1977, I am forwarding copies of the documents you requested.

If I can be of further assistance in this matter, please contact me.

Yours very truly,

Marion De Grove
(Mrs.) Marion De Grove
Assistant Pollution Control
Engineer

MDeG/lwr

Enclosures

AREA CODE 904 / AIR POLLUTION -633-3303 / WATER POLLUTION -633-3415
515 WEST 6TH STREET / JACKSONVILLE, FLORIDA 32202

(12)

BARBECUE RESTAURANTS

Jacksonville has approximately 120 restaurants which use wood or charcoal to cook meat. They contribute almost 80 tons of particulate matter to our atmosphere annually.

Most of those which use charcoal and advertise "charcoal grilled" meat use only nominal amounts of charcoal and cook almost entirely by gas. The wood burning barbecue restaurants are the major source of the smoke and odors which have caused citizens to complain to the Air Pollution Control Activity.

The smoke is composed of greasy, organic particulate matter, and the odors are caused by organic gases. These emissions may be controlled by incineration, using an afterburner, or by collection using an electrostatic precipitator or a filtration system.

A well designed afterburner, operating at a sufficiently high temperature, should remove both the particulate and gaseous pollutants. The initial cost, about $6000 per restaurant, is relatively low, but operating costs can be over $3000 per year. Some afterburners, so called "smoke eliminators", operate at temperatures too low to control gaseous pollutants, and they reduce visible emissions primarily by vaporizing the liquid particulates. These have greatly reduced operating costs, but have little effect on the total emissions.

Low voltage electrostatic precipitators or fiberglass filtration systems can collect a substantial protion of the particulate matter and thus reduce visible emissions, but do not remove any of the gaseous pollutants.

The initial cost of an electrostatic precipitator, a minimum of about $8000, is relatively high but operating costs are minimal. However, preventing a build up of grease, which interferes with the operation of the precipitator, necessitates a high degree of maintenance.

Fiberglass filtration for a restaurant of moderate size costs no more than an afterburner, without the high operating costs. For large restaurants, however, the initial costs are greater. This type of control is relatively new and therefore has not been applied to many different types of restaurants.

A regulation requiring zero visible emissions and no odors could only be met by the installation of afterburners in all barbecue restaurants. The control efficiency would be very high, better than 95%. However, for small restaurants, the high operating costs of an afterburner might be a hardship. The fact that the operation of so many afterburners would consume large quantities of natural gas is a consideration also, with the anticipated shortage of this fuel in the near future.

Existing regulations limiting opacity to 20% with no objectionable odors can be met by some of the smaller restaurants without the installation of control equipment. The larger restaurants would have the option of choosing control equipment from the types discussed here, while the largest would probably still have to use afterburners. Over half of the total emissions come from about a dozen large restaurants, so the reduction in total emissions would be substantial - 60% to 70%.

Enforcement of existing regulations is the recommendation of the Air Pollution Control Activity.

ASSUMPTIONS -

40 restaurants use wood.

(a) 12 restaurants - 104 cords/year each

(b) 8 restaurants - 24 cords/year each

(c) 20 restaurants - 18 cords/year each

1 cord weighs 2.25 tons

Emission factor - 37.5 # particulate/ton wood

(a) (104 cords/yr)(2.25 tons/cord)(37.5 #/ton)(1 ton/2000#) = 4.4 tons

12 restaurants = (4.4 tons)(12) = 52.8

(b) (24 cords/yr)(2.25 tons/cord)(37.5 #/ton)(1 ton/2000#) = 1 ton

8 restaurants = (1ton)(8) = 8 tons

(c) (18 cords/yr)(2.25 tons/cord)(37.5 #/ton)(1 ton/2000#) = .76 tons

20 restaurants = (.76 tons)(20) = 15.2 tons

TOTAL 52.8 + 8 + 15.2 = 76 tons

20 restaurants use charcoal, average 10 tons/year

Emission factor - 34 # particulate/ton charcoal

(20 rest)(10 tons/yr. charcoal)(34 #/ton)(1 t/2000#) = 3.4 tons/yr.

TOTAL 76 = 3.4 = 79.4 tons

ENVIRONMENTAL PROTECTION AGENCY
REGION IV
AIR PROGRAMS BRANCH

SUMMARY REPORT

CONTROL OF EMISSIONS FROM RESTAURANTS AND COMMERCIAL BARBECUE PITS

I. Background

With the first steps already taken toward the control of large industrial air pollution sources, more and more attention is being given to the smaller sources such as commercial barbecue pits and charcoal-broilers. The Technical Assistance Section has received many requests from the State and local air pollution control agencies in Region IV for information on controlling emissions from these sources. One main concern with sources of this type is the cost of pollution control; control technology is available, but most custom design systems cost in excess of $7,000 - $8,000. Of interest to the owners of these sources is an add-on type device at a lower initial cost.

II. Discussion

Emissions from barbecue pits and charcoal-broilers are greasy, organic particulates along with some organic gases. The emissions may be controlled by either collection, using a low voltage electrostatic precipitator, or by incineration, using an afterburner. Low voltage precipitators can be used to collect a substantial portion of the particulates responsible for visible air contamination. They do not however remove any gaseous pollutants which are usually responsible for odors and eye irritation. ESP's have a relatively high initial cost compared to afterburners, however, the operating costs are considerably lower. Precipitators must be kept clean requiring a relatively high degree of maintenance. Afterburners can be used to remove both particulate and gaseous pollutants. Since most of the contaminants from charcoal-broilers and barbecue pits are combustible, a well-designed afterburner should provide adequate control if the operating temperature is sufficiently high. Compared to precipitators, afterburners have a relatively low initial cost but operating costs are high. Nevertheless, maintenance is much less a problem because there is no build up of grease in the afterburner to impede its operation.

Table I is a listing of manufacturers of control devices for control of charcoal-broiler and/or barbecue pit emissions. Only those companies which has estimated initial costs under $7,000 were included in the list. Many of the larger companies produce only large industrial equipment and were unwilling to accept small-scale jobs. Many other companies required that the units be custom designed, thus raising the initial cost to over $7,000.

It should be noted that some of the afterburners listed are so-called "smoke-eliminators" and operate at temperatures considerably below that necessary to eliminate the gaseous pollutants. Their main function is to vaporize the liquid particulates, thus reducing visible emissions. Although they effectively control the visible emissions, they do little to alleviate the overall pollution entering the atmosphere. These factors should be considered when choosing a control device of this type.

III. Conclusions:

Pollution control equipment for barbecue pits and charcoal-broilers does exist at initial costs of less than $7,000, however, operational costs are likely to be quite high. Both afterburners and electrostatic precipitators, if properly designed, should significantly reduce visible emissions. Afterburners generally have lower initial costs and require less maintenance than precipitators but operating costs are quite high (up to $3,000/year). In addition, the natural gas required for its operation is not available in some locations.

Roy Segars
July 21, 1972
Revised 10-03-72

TABLE I AVAILABLE EQUIPMENT FOR CONTROL OF EMISSIONS FROM BARBECUE PITS AND CHARCOAL BROILERS *

Manufacturer	Type of Control Equipment	Previous Experience **	Estimated Initial Cost
Aerodyne Corporation Charlotte, N. C. 704-525-8648	Afterburner	Yes	$3000 - $4000
American Equipment Co. Kansas City, Mo. 816-361-0778	Afterburner	Yes	$3000 - $4000
Brule, C. E. & E., Inc Blue Island, Ill. 312-388-7900	Afterburner Scrubber	Yes No	Not available Not available
Clean Air Combustion Corp. Frederick, MD. 301-663-8333	Afterburner	Yes	$2500 - $3000
Commercial Fabrication Co. Mount Airy, N. C. 919-786-8374	Afterburner - Scrubber Package	Yes	$4000 - $5000
Mid-South Manufacturing Corp Houston, Texas 713-666-6243	Afterburner	No	$3350 - $8000
Ransome Corp. San Leandro, Calif. 415-352-3751	Afterburner	No	$4000 - $8000
Sears-Westall Co. St Louis, Mo. 314-968-1260	Afterburner	Yes	$2500 - $3500

Continued

TABLE I (CONTINUED)

Manufacturer	Type of Control Equipment	Previous Experience **	Estimated Initial Cost
Texas Electronic Precipitator Co. Garland, Texas 214-276-0591	Electrostatic Precipitator	Yes	<$5000
Trion Corp Sanford, N.C. 919-775-2201	Electrostatic Precipitator	Yes	$3000-$5000
United Air Specialists Cincinnati, Ohio 513-891-0400	Electrostatic Precipitator	Yes	<$8000
Vari-Systems, Inc. Cleveland, Ohio 216-651-7708	Afterburner	No	$3500 up
International Environmental Products Los Angeles, CA. 213-466-1611	Electrostatic Precipitator	Yes	$6000 up

* Initial Cost less than $7,000

** Have installed control equipment on commercial barbecue pits and/or charcoal-broilers as of 7/21/72

Monsanto Enviro-Chem

Monsanto Enviro-Chem Systems Inc.
Corporate Square Office Park
Box 14547
St. Louis, Missouri 63178
Phone: (314) 694-1000

August 23, 1977

Mr. Mark Bornstein
GCA/Technology Division
Burlington Road
Bedford, MA 01730

Dear Mark:

I was happy to chat with you on the phone yesterday. I understand you are using two reports Monsanto Enviro-Chem prepared, to wit:

- AD-S-15-20199 dated September 24-26, 1974, entitled Evaluation Of Pilot Plant Performance, Hardee's Food System, Inc., Upper Marlboro, Maryland.
- AD-S-15-20242 dated August 18-19, 1976, entitled Results Of Sampling The Conqueror At Hardee's Restaurant No. 6, Rocky Mount, North Carolina.

Confirming our phone discussion, these reports are not confidential and you may extract data from them for your study being prepared for the EPA. We reserve the right to review your use of the data and would appreciate a copy of your report when published. If you have any other questions about our work with charbroiler restaurants, please do not hesitate to call me.

Very truly yours,

Robert W. Galbierz

Robert W. Galbierz
Product Manager

/daz
cc: Mr. Bill Herring, EPA

GCA/TECHNOLOGY DIVISION

29 August 1977

Mr. Alan Ingram
Bonanza International Inc.
8350 N. Central Expressway
Dallas, Texas 75206

Dear Mr. Ingram:

GCA is presently under contract with the United States Environmental Protection Agency to develop background information for the direct meat firing industry. This information will be used to develop emission factors which will assist in the development of possible new source performance standards for this industry.

As I explained in our conversation of 26 August 1977, we are searching for basically two types of information which will enable us to prepare a description of the industry. The first type is actual emission data obtained through the sampling of the emissions emitted to the atmosphere by the cooking operation. The second type is market statistics; parameters that influence emissions. It is this latter information, as specified in more detail below, that is of prime concern for this current request.

We are interested in obtaining sufficient information to prepare a background description of the domestic direct firing industry. In this regard, we have identified certain parameters that influence the emission quantities from these operations. These parameters concern the cooking operation used, the food prepared and the number of customers serviced. Specifically, with regard to these parameters, we have identified the following:

- Cooking Operation
    - Cooking equipment
    - Operation temperature
    - Type and amount of fuel
- Food Preparation
    - Type and amount of meats cooked per hour
- Customers
    - Customer rates (distribution by time of day and season)
    - Plant size
    - Sales Volume

RLINGTON ROAD, BEDFORD, MASSACHUSETTS 01730 / PHONE: 617-275-9000

Again, the concern of our present study is the direct meat firing industry. As such, it would be desirable if the above data or other statistics that you can supply would be representative of meat preparation and not those foods prepared by other means.

I like to thank you for your assistance in this matter and I shall look forward to receiving the information.

If there are any problems or if you need further clarification, do not hesitate to call.

Sincerely yours,

Alan Castaline

AC:ms

BONANZA

Bonanza International, Inc.

September 23, 1977

Mr. Alan Castaline
GCA/Technology Division
Burlington Road
Bedford, Massachusetts 01730

Dear Mr. Castaline:

On receipt of your letter, I spoke with our construction department regarding the information you needed.

Unfortunately, we can be of little help in the area of cooking and food prep. We do use gas fired broilers (natural or propane). The majority of our equipment is produced by the Wolf Range Company. There is also some deep frying using Wells deep fryers.

Our meats are solid beef products (35%), chopped steak products (20-25% fat content) - (30%) and deep fried products (15%) with the balance in sandwiches or non-cooked products.

Our buildings are approximately 4600 square feet in size. The average restaurant averages approximately 3,500 customers per week with a $3 check average. There is a slightly higher volume during the summer months which is offset by lower volume in the winter.

Hope this information will prove useful.

Cordially,

Alan Ingram

Alan Ingram
Advertising Services Director

AI:fr

1000 Campbell Centre ■ 8350 N. Central Expressway ■ Dallas, Texas 75206 ■ 214/363-1011

REPORT OF TELEPHONE CONVERSATION
DIRECT MEAT FIRING INDUSTRY

DATE: 8/30/77

PERSON CALLED: Mr. Jackson

ORGANIZATION: Air Filters Inc.

ADDRESS: Richmond, Va.

TEL. NO. (804) 321-6458

GCA PERSONNEL: Mark Bornsteain

SUBJECT MATTER:

Mr. Jackson was questioned about the use of activated charcoal for restaurant charbroilers. Because of the grease present the unit would plug up in as short a time as 2 days. After it gets coated with grease the unit will no longer be effective in removing hydrocarbons. He also stated that he does not know of any restaurant using activated charcoal to control hydrocarbon emissions from a charbroiler.

GCA/TECHNOLOGY DIVISION GCA

30 August 1977

Mr. Maurice O'Shaughnessy
National Maintenance
Sizzler Family Steak Houses
12731 W. Jefferson Boulevard
Los Angeles, California 90066

Dear Mr. O'Shaughnessy:

GCA is presently under contract with the United States Environmental Protection Agency to develop background information for the direct meat firing industry. This information will be used to develop emission factors which will assist in the development of possible new source performance standards for this industry.

We require basically two types of information which will enable us to prepare a description of the industry. The first type is actual emission data obtained through the sampling of the emissions emitted to the atmosphere by the cooking operation. The second type is market statistics; parameters that influence emissions. It is the former information, as specified in more detail below, that is of prime concern for this current request.

We are interested in obtaining sufficient information to prepare a background description of the domestic direct firing industry. In regard to the engineering aspects of the cooking operation, we have identified certain parameters that influence the total emissions from these operations. These parameters concern the cooking equipment used, the emission control device installed, the food prepared, and the number of customers serviced. Specifically, with regard to these parameters, we have identified the following:

- Cooking Equipment

    Equipment type or name
    Operation temperature
    Type and amount of fuel

- Emission Control Devices

    Equipment type or name and cost
    Operating costs and procedures (including maintenance)
    Uncontrolled emission quantities (emission test report, if available)
    Control device efficiency (engineering test report, if available)

BURLINGTON ROAD, BEDFORD, MASSACHUSETTS 01730 / PHONE: 617-275-9000

Mr. Maurice O'Shaughnessy
Sizzler Family Steak Houses
30 August 1977
Page Two

- Food Preparation

  Type and amount of meats cooked per hour

- Customers

  Customer rates (distribution by time of day, day of week, and season)
  Customer profile
  Sales volume

I realize that you may not have direct access to data sufficient to reply to the last category. This information is typically compiled by corporate marketing research divisions.

I will be most appreciative if you could forward this letter to this division or its equivalent at Sizzler.

Again, the concern of our present study is the direct meat firing industry. As such, it would be desirable if the above data or other statistics that you can supply would be representative of meat preparation and not those foods prepared by other means.

I would like to thank you for your assistance in this matter and I shall look forward to receiving the information.

If there are any problems or if you need further clarification, do not hesitate to call.

Sincerely yours,

Alan Castaline

Alan Castaline

AC:ms

GCA/TECHNOLOGY DIVISION GCA

30 August 1977

Mr. Kenneth Morick
Director of Marketing Research
Burger King Corporation
7360 N. Kendall Drive
Miami, Florida 33176

Dear Mr. Morick:

GCA is presently under contract with the United States Environmental Protection Agency to develop background information for the direct meat firing industry. This information will be used to develop emission factors which will assist in the development of possible new source performance standards for this industry.

As I explained in our conversation of 30 August 1977, we are searching for basically two types of information which will enable us to prepare a description of the industry. The first type is actual emission data obtained through the sampling of the emissions emitted to the atmosphere by the cooking operation. The second type is market statistics; parameters that influence emissions. It is this latter information, as specified in more detail below, that is of prime concern for this current request.

We are interested in obtaining sufficient information to prepare a background description of the domestic direct firing industry. In this regard, we have identified certain parameters that influence the emission quantities from these operations. These parameters concern the cooking operation used, the food prepared and the number of customers serviced. Specifically, with regard to these parameters, we have identified the following:

- Cooking Operation
    - Cooking equipment
    - Operation temperature
    - Type and amount of fuel
- Food Preparation
    - Type and amount of meats cooked per hour
- Customers
    - Customer rates (distribution by time of day, day of week, and season)
    - Plant size
    - Sales volume
    - Customer profiles

BURLINGTON ROAD, BEDFORD, MASSACHUSETTS 01730 / PHONE: 617-275-9000

I understand from our conversation that the data at your access focuses primarily on the third group. I would appreciate any available information that you believe could assist in the preparation of a background description of the industry. I will be contacting Mr. Al Bennett, at your suggestion, to inquire about the engineering aspects of Burger King operations.

Again, the concern of our present study is the direct meat firing industry. As such, it would be desirable if the above data or other statistics that you can supply would be representative of meat preparation and not those foods prepared by other means.

I like to thank you for your assistance in this matter and I shall look forward to receiving the information.

If there are any problems or if you need further clarification, do not hesitate to call.

Sincerely yours,

Alan Castaline

Alan Castaline

AC:ms

C V M CORPORATION
402 VANDEVER AVENUE
WILMINGTON, DELAWARE 19802
(302) 654-7070

August 30, 1977

GCA Technology Division
Burlington Road
Bedford, Mass. 01730

Attention: Mr. Alan Castaline

Re: CVM Fume Eliminators in Charco-Broiling Restaurants

Dear Sir:

This letter relates to our telephone conversation this week, in which you asked for further information on our experience in handling charcoal broiling units.

The two installations we had were at Franchise Enterprises-Hardee's restaurants at High Point and Jamestown, North Carolina. They had been operating about one year. During this time, we sold them two sets of replacement elements. Price of the elements per unit was $600.00 per set.

The latest information we have is that these units have been dismantled and are not now in service. They demonstrated the ability to eliminate the fumes, but the need for periodic maintenance, even at six-month intervals, was too much for the clients.

At the present time, we have a pilot unit available working on a different principle which we think will handle this problem with lower maintenance; however, we are not agressively pursuing these applications because of the volume of work we have in textile applications.

If you hear of someone who is fed up with paying the high fuel costs of afterburners and the high maintenance costs for electrostatic precipitators and the Brinks filter type fume eliminator units, tell them we can offer a pilot unit for a nominal sum to demonstrate performance of our new design.

Thank you for your interest in CVM Corporation. At present, we will continue to devote our energies to handling textile and roofing asphalt industry problems, fields in which we are very successful and well-known.

Very truly yours,

John L. Wilki

JLW:jtb

REPORT OF TELEPHONE CONVERSATION
DIRECT MEAT FIRING INDUSTRY

DATE: 9/8/77

PERSON CALLED: Mr. B. Matthau

ORGANIZATION: Standard - Keil/Klein Hardware

ADDRESS: Rt. 34 and Allenwood Rd.
Allenwood, N.J. 08720

TEL. NO. (201) 449-3700

CCA PERSONNEL: M.B.

SUBJECT MATTER:

Mr. Matthau stated that due to the present fire codes all cooking areas must have an approved grease collector over their grills. Baffle type collectors are of the type that are usually used. The efficiency of these units range from 60 to 70 percent for grease. Water wash systems have efficiencies over 90 percent while wire mesh collectors are lower than 60 percent. He feels that maybe only 10 percent of the grease will actually go out the stack since: a good portion of it is either burned, spattered on the wall and hood surfaces or is collected on the charbroiler grease trap.

REPORT OF TELEPHONE CONVERSATION
DIRECT MEAT FIRING INDUSTRY

DATE: 9/8/77

PERSON CALLED: Mr. Tom Capalbo

ORGANIZATION: Flame Gard

ADDRESS: 6464 Corvette St.
Los Angeles, Ca.

TEL. NO. (213) 685-4869

GCA PERSONNEL: M.I.B.

SUBJECT MATTER:

I questioned Mr. Capalbo about the average efficiency of grease collectors presently used. He stated that water wash systems are the best and are capable of the 95 percent efficiency as stated in the literature but the average restaurant does not use this system. They use either a mesh screen or a baffle type of filter with an average efficiency of about 60 percent.

REPORT OF TELEPHONE CONVERSATION
DIRECT MEAT FIRING INDUSTRY

DATE: 7/21/77

PERSON CALLED: John Uhlman - Art Seeds

ORGANIZATION: Charcoal Briquette Inst.

ADDRESS: Oakbrook, Ill.

TEL. NO. (312) 654-4010

GCA PERSONNEL: M.B.

SUBJECT MATTER:

Mr. Seeds stated that his organization does not keep any records for restaurant charcoal consumption. He estimated however that less than 1 percent of all restaurants use charcoal.

REPORT OF TELEPHONE CONVERSATION
DIRECT MEAT FIRING INDUSTRY

DATE: 8/15/77

PERSON CALLED:

ORGANIZATION: Missouri Air Conservation Commission

ADDRESS: P.O. Box 1062
117 Commerce Ave.
Jefferson City, Missouri 65101

TEL. NO. (314) 751-2151

GCA PERSONNEL: A.H.C.

SUBJECT MATTER:

The MACC's territory of coverage only the "out-state" areas which excludes Kansas City, Springfield, and St. Louis City and County. The State does not enforce Process Weight Regulations on Industry.

REPORT OF TELEPHONE CONVERSATION
DIRECT MEAT FIRING INDUSTRY

DATE: 8/15/77

PERSON CALLED: Mr. Marlowe

ORGANIZATION: New York State Dept. Envir. Cons.

ADDRESS: 50 Wolf Road
Albany, NY 12201

TEL. NO. (518) 457-5118

GCA PERSONNEL: A.H.C.

SUBJECT MATTER:

Restaurants exempt from provisions of part 201 (issuance of construction permits) and part 212 (process weight regulations). Concentration standards and opacity limitations would apply. Enforcement is at bottom of priority list (sources are inspected upon complaints only).

REPORT OF TELEPHONE CONVERSATION

DIRECT MEAT FIRING INDUSTRY

DATE: 8/15/77

PERSON CALED: Steve White et al.

ORGANIZATON: Division of Air Pollution
Tennessee Dept. of Public Health

ADDRESS: C2-212 Cordell Hull Bldg.
Nashville, TN 37219

TEL. NO. (615) 741-3931

GCA PERSONEL: A.H.C.

SUBJECT MTTER:

Process weight regulations are not enforced. However, there exists a fairly large visual emissions problem from Bar-B-Que operations. Some testing has been completed on these operations and will be made available to GCA if the company will permit its release. The results of the tests showed that mass emissions were in compliance with standards, but that violations of the visual standards did occur. At the present time operations are meeting visual requirements due to the addition of control equipment.

From Chain Restaurant Operators Guide (Tennessee)

Big John's Bar-B-Q	(5)
Leonard's Pit Barbeque, Inc	(6)
Loeb's Bar-B-Q	(17)
Jimmie Noel s Bar-B-Q	(4)
Tops Bar-B-Q, Inc.	(13)

REPORT OF TELEPHONE CONVERSATION
DIRECT HEAT FIRING INDUSTRY

DATE: 8/15/77

PERSON CALLED: ______________________

ORGANIZATION: Dept. of Pollution Control

ADDRESS: 2562 Executive Center Circle
Tallahassee Florida 32301

TEL. NO. (904) 488-1344

GCA PERSONNEL: A.H.C.

SUBJECT MATTER:

The State of Florida does not have an applicable Process Weight Regulation. There is an applicable visual emission rule; however investigations are initiated on a complaint basis only. Dade County (Miami Area) has a more specific permit requirement.

REPORT OF TELEPHONE CONVERSATION

DIRECT MEAT FIRING INDUSTRY

DATE: 8/15/77

PERSON CALLED: Robert Kappelman

ORGANIZATION: Dept. of Health, Welfare & Bio-Environmental Services

ADDRESS: 515 W. 6th St.
Jacksonville, Florida 32206

TEL. NO. (904) 633-3303

GCA PERSONNEL: A.H.C.

SUBJECT MATTER:

The direct meat-firing operation is popular in the Jacksonville area, especially operations such as Hardee's, steak houses, and Bar-B-Q pits (many wood-fired). Of approximately 650 to 700 restaurants in the area, 200 to 300 are direct meat-firing and nearly 50 Bar-B-Q's. The City Environmental Protection Board expressed policy is not to enforce regulations on industry because of manpower limits, and because it is more important to continuously monitor the activities of large sources such as pulp mills. Some data had been collected to support decisions which showed that restaurant operations were minor emitters. (This data may be available to GCA.) The data also exhibited that it is primarily visual emissions that create problems rather than process weight. Investigations are initiated on response to compliants received from the public.

REPORT OF TELEPHONE CONVERSATION
DIRECT MEAT FIRING INDUSTRY

DATE: 8/16/77

PERSON CALLED: Mr. Gerry Liefert

ORGANIZATION: D.A.Q., M.P.C.A.

ADDRESS: 1935 West County Road
Roseville, Minnesota 55113

TEL. NO. (612) 296-7272

CCA PERSONNEL: A.H.C.

SUBJECT MATTER:

The State of Minnesota does not ordinarily enforce the process weight regulations on the direct meat-firing industry. Further, visual emission inspections are not performed on a regular basis, inspections are initiated upon public complaints only. Testing has been conducted at a number of establishments in the past, including a Hardee's in Rochester and an Arthur Treacher's in Richfield, MN. Emission Test Reports may be available from Mr. Edward M. Wiik, Director of the Division of Air Quality (a letter dated 8/16/77 was sent requesting reports).

REPORT OF TELEPHONE CONVERSATION
DIRECT MEAT FIRING INDUSTRY

DATE: 8/17/77

PERSON CALLED: Air Quality Bureau

ORGANIZATION: Dept. of Environmental & Community Services

ADDRESS: State House
Boise, Idaho 83720

TEL. NO. (208) 384-2903

GCA PERSONNEL: A.H.C.

SUBJECT MATTER:

No action has been taken with respect to either process weight or opacity regulations.

REPORT OF TELEPHONE CONVERSATION

DIRECT MEAT FIRING INDUSTRY

DATE: 8/17/77

PERSON CALLED: Mr. Bob Wiscomy

ORGANIZATION: Air Quality Section,
Bureau of Environmental Health LH SRA

ADDRESS: P.O. Box 60630
New Orleans, LA 20760

TEL. NO. (504) 568-5121

GCA PERSONNEL:

SUBJECT MATTER:

The State does not enforce process weight or opacity regulations. Investigations would be performed upon public complaint; however, no such investigation can be recalled.

REPORT OF TELEPHONE CONVERSATION
DIRECT HEAT FIRING INDUSTRY

DATE: 8/17/77

PERSON CALLED:

ORGANIZATION: Washington State Dept. of Ecology

ADDRESS: P.O. Box 829
Olympia, Washington 98504

TEL. NO. (206) 753-2821

GCA PERSONNEL: A.H.C.

SUBJECT MATTER:

The State of Washington does not have an applicable process weight regulation; visual emissions regulations would apply, however. One local agency cited one restaurant (cooking of salmon) recently; otherwise no other cases can be recalled.

REPORT OF TELEPHONE CONVERSATION

DIRECT MEAT FIRING INDUSTRY

DATE: 8/19/77

PERSON CALLED: Mr. Ramadass

ORGANIZATION: District ofColumbia DES
Bureau of Air & Water Pollution Control

ADDRESS: 614 H St. NW
Washington, D.C. 20001

TEL. NO. (202) 629-2568

GCA PERSONNEL: A.H.C.

SUBJECT MATTER:

Washington, D.C. does enforce Process Weight and Visual Emission Regulations on the direct meat-firing industry. There is also a permit requirement for construction. If an establishment is cited it must install control equipment if not presently equipped.

REPORT OF TELEPHONE CONVERSATION
DIRECT MEAT FIRING INDUSTRY

DATE: 8/19/77

PERSON CALLED: Marion De Groye

ORGANIZATION: Bio-Environmental Services

ADDRESS: 515 W. 6th St.
Jacksonville, Florida 32206

TEL. NO. (904) 633-3303

GCA PERSONNEL: A.H.C.

SUBJECT MATTER:

She is sending a two-page document she prepared and submitted to the City Environmental Board which stresses the need to control emissions from Bar-B-Que operations. The Jacksonville area has a large number of this type of operation. She is also sending a copy of an EPA Region IV publication, "Control of Emissions from Restaurants and Commercial Bar-B-Que Pits." She also suggested contacting a Mr. Wicki of CDM Corp. (Control Equipment Manufacturer) who has assembled some literature on the subject.

(302) 654-7070).

REPORT OF TELEPHONE CONVERSATION

DIRECT MEAT FIRING INDUSTRY

DATE: 8/19/77

PERSON CALLED: David Taylor

ORGANIZATION: Air Quality Control

ADDRESS: South Carolina Dept. of Health and Environmental Control
Columbia, SC 29201

TEL. NO.

GCA PERSONNEL: A.H.C.

SUBJECT MATTER:

Do not interpret process weight or opacity regulations to be applicable to these operations.

REPORT OF TELEPHONE CONVERSATION
DIRECT MEAT FIRING INDUSTRY

DATE: 8/23/77

PERSON CALLED: Don Wambagans

ORGANIZATION: D.C. DES Bureau of Air & Water Pollution Control

ADDRESS: Washington, D.C. 20001

TEL. NO. (202) 629-3748

GCA PERSONNEL: A.H.C.

SUBJECT MATTER:

Washington, D.C. is very strict in the enforcement of process weight, opacity and odors regulations on direct meat-firing operations. Establishment must file a permit for control equipment specifying baseline emissions and control equipment efficiency. He provided the following emissions data for the Hardee's in D.C.

Uncontrolled .014 .017 .026 grains/dscf front
.021 .027 .033 grains/dscf total - back

Controlled .004 grains/dscf front
.010 to .011 grains/dscf total - back

He also referred to a two-story Burger King downtown, two blocks from the White House, built between two ten-story buildings. The emissions (smoke and odors) penetrate the windows of the adjoining structures. The Burger King has been required to install controls, and has selected The Hardee's Conqueror. However, if it does not provide proper control, it must be replaced. He mentioned that places like Rustler Steak House and other charbroiler operations are closely watched.

REPORT OF TELEPHONE CONVERSATION

DIRECT MEAT FIRING INDUSTRY

DATE: 8/23/77

PERSON CALLED: Mr. Cahill

ORGANIZATION: Metropolitan Dade County Pollution Control Dept.

ADDRESS: 864 N.W. 23rd St.

Miami, Florida 33125

TEL. NO. (305) 579-2760

GCA PERSONNEL: A.H.C.

SUBJECT MATTER:

Direct meat-firing industry is not considered a problem in Dade County. There have been a few instances of operations violating opacity regulations in recent years, but still minor.

REPORT OF TELEPHONE CONVERSATION

DIRECT MEAT FIRING INDUSTRY

DATE: 8/23/77

PERSON CALLED: Bill Reefe

ORGANIZATION: APCD, Colorado Dept. of Health

ADDRESS: 4210 E. 11th Ave.
Denver, Colorado 80220

TEL. NO. (303) 388-6111 X371

GCA PERSONNEL: A.H.C.

SUBJECT MATTER:

The State does not enforce process weight regulations on restaurants. Opacity (20 percent) and odor regulations are in effect; however, citations are generally issued only upon public complaint initiated investigation. The local agencies are usually responsible for monitoring the small emission sources throughout the State. He referred to local problems in Aspen and Denver.

REPORT OF TELEPHONE CONVERSATION

DIRECT HEAT FIRING INDUSTRY

DATE: 8/23/77

PERSON CALLED: Tom Dunlap

ORGANIZATION: Dept. of Health

ADDRESS: Aspen, Colorado

TEL. NO. (303) 925-2020

GCA PERSONNEL: A.H.C.

SUBJECT MATTER:

Grill type restaurant operations are a large problem in Aspen. Of 90 restaurants in the community, 72 are direct-firing. This ski resot town is located in a mountain valley in an area of the country where inversions frequently compound air quality levels. The primary sources of emissions are motor vehicles and roadway sanding, fireplaces, and restaurants.

One operation has been convinced to change cooking equipment to a griddle (nondirect-firing). Others have tried to turn down cooking temperatures from 750° - 900° to 300° which substantially reduced emissions but was not practical because it reduced the cooking load factor. Use of an afterburner is believed to be dangerous and expensive: dangerous because of the high temperature (1400° to 2000°) of operation and the old age of the existing buildings and expensive because of the amount of natural gas consumed. Electrostatic precipitators were tried unsuccessfully.

U.S. EPA and Colorado Dept. of Health are co-sponsoring an emission inventory study in Aspen, Vail and two other mountain towns. This study will include development of restaurant emission factors in Vail to be used in Aspen. A particulate size study will begin in December in Aspen to determine the relative influence of roadway sanding, fireplaces, and restaurants.

REPORT OF TELEPHONE CONVERSATION
DIRECT MEAT FIRING INDUSTRY

DATE: 8/24/77

PERSON CALLED: David Kircher

ORGANIZATION: EPA Region VIII

ADDRESS: 186 Lincoln St.
Denver, Colorado

TEL. NO. (303) 837-3711

CCA PERSONNEL: A.H.C.

SUBJECT MATTER:

Purpose of call was to inquire about The Colorado Mountain Community Assessment Study being conducted in the communities of Aspen, Vail, Steamboat Springs and Telloride and being funded by the Colorado Health Department and USEPA. The study is intended to produce an emission inventory for these communities where fireplaces, woodburning stoves, and charbroilers are the major sources of emissions. A small contract has been let to Pedco of Kansas City to develop appropriate emission factors. Mr. Ken Axetell of Pedco is managing Pedco's efforts which will include an emission test of one charbroiler operation in Vail. This test will not take place until late October.

REPORT OF TELEPHONE CONVERSATION
DIRECT MEAT FIRING INDUSTRY

DATE: 8/25/77

PERSON CALLED: Annette Cadwell

ORGANIZATION: National Restaurant Assoc.

ADDRESS: One IBM Plaza, Suite 2600
Chicago, Illinois 60611

TEL. NO. (312) 787-2525

GCA PERSONNEL: A.H.C.

SUBJECT MATTER:

The purpose of this call was to request descriptive and statistical information regarding the operation of the restaurant business, and specifically the direct meat-firing industry, if available. Ms.Cadwell agreed to supply a standard information package.

REPORT OF TELEPHONE CONVERSATION

DIRECT MEAT FIRING INDUSTRY

DATE: 8/25/77

PERSON CALLED: Doug J. Smith

ORGANIZATION: Ponderosa Systems, Inc.

ADDRESS:
Dayton Municipal Airport
Box 578
Dayton, Ohio 45401

TEL. NO. (513) 890-6400

GCA PERSONNEL: A.H.C.

SUBJECT MATTER:

Mr. Doug Smith, Vice President of Construction and Engineering at Ponderosa, stated that Ponderosa has never reviewed the emission characteristics of their operations. He suggested calling The National Restaurant Association for market statistics on customer profiles, sales volume, etc.

REPORT OF TELEPHONE CONVERSATION
DIRECT MEAT FIRING INDUSTRY

DATE: 8/26/77

PERSON CALLED: Richard Dickerson

ORGANIZATION: Health Effect Research

ADDRESS: U.S. EPA RTP

Durham, N.C.

TEL. NO. (419) 541-2111

GCA PERSONNEL: A.H.C.

SUBJECT MATTER:

Richard Dickerson was involved with an odor study which included the review of a restaurant operation in Tampa, Florida when he was employed with U.S. EPA, Region IV, Atlanta.

REPORT OF TELEPHONE CONVERSATION
DIRECT MEAT FIRING INDUSTRY

DATE: 8/26/77

PERSON CALLED: Alan Ingram

ORGANIZATION: Bonanza International, Inc.

ADDRESS: 8350 N. Central Expressway
Dallas, Texas 75206

TEL. NO. (219) 363-1021

GCA PERSONNEL: A.H.C.

SUBJECT MATTER:

Mr. Alan Ingram of the Marketing Research Department at Bonanzo agreed to supply statistical data for various items such as customer rate and distribution, sales volumes, amount of meat prepared, etc. However, he requested a formal letter transmitting our search for statistical data.

(Refer to letter sent to Mr. Alan Ingram, 29 August 1977)

REPORT OF TELEPHONE CONVERSATION

DIRECT MEAT FIRING INDUSTRY

DATE: 8/29/77

PERSON CALLED: John Martz

ORGANIZATION: Ohio EPA

ADDRESS: 361 E. Broad St.
Columbus, Ohio 43216

TEL. NO. (614) 466-7390

GCA PERSONNEL: A.H.C.

SUBJECT MATTER:

Recalled a number of complaints in past years primarily with regards to opacity and odors from fast food operations. He is unaware of the resolution of these issues. Suggests speaking to personnel at district office.

REPORT OF TELEPHONE CONVERSATION
DIRECT MEAT FIRING INDUSTRY

DATE: 8/29/77

PERSON CALLED: Joe Cabean

ORGANIZATION: Ohio EPA

ADDRESS: Columbus District Office
Columbus, Ohio

TEL. NO. (614) 466-6450

GCA PERSONNEL: A.H.C.

SUBJECT MATTER:

Investigations are initiated upon public complaints which are usually brought about because of odors. He cited two cases in past years which were in violation, one eventually ceased operations and the other raised its stack, solving its problem. Ohio regulations are too cumbersome in regard to involvements with the industry; the preferred means is to employ direct negotiations with the management to reach toward a mutually satisfactory solution.

REPORT OF TELEPHONE CONVERSATION

DIRECT MEAT FIRING INDUSTRY

DATE: 8/30/77

PERSON CALLED: Mr. Wicki

ORGANIZATION: CDM Corp.

ADDRESS: Wilmington, Delaware

TEL. NO. (302) 654-7070

GCA PERSONNEL: A.H.C.

SUBJECT MATTER:

CDM Corp. is a control equipment manufacturer; 80 to 90 percent of its business is with the textile industry. They make a fume smoke control device for the textile plants. They have built and installed two fiberglass tube fume eliminators in two Hardee's units franchised by Franchise Enterprise, Inc. of Rocky Mount, N.C. CDN's equipment has considerably more surface area than other filter type devices and thus, requires less frequent replacements (CDM equimment requires filter change at about 8-month intervals). Will forward literature.

REPORT OF TELEPHONE CONVERSATION

DIRECT HEAT FIRING INDUSTRY

DATE: 8/30/77

PERSON CALLED: Mr. Kenneth Morick

ORGANIZATION: Burger King Corp.

ADDRESS: 7360 N. Kendall Drive
Miami, Florida 33176

TEL. NO. (305) 596-7011

GCA PERSONNEL: A.H.C.

SUBJECT MATTER:

Mr. Morick has agreed to supply various market data. (Refer to Letter of 30 August 1977). He suggested speaking to Mr. Al Bennent Vice President Engineering with regard to engineering and environmental controls.

FIRE CHIEF/Fire Fighter

We are very pleased to report that the results of recent tests by a nationally known certified testing laboratory prove beyond doubt that the Standard-Keil FIRE FIGHTER is the top performer in removing grease from kitchen hoods and ducts. This confirms all the favorable reports we've received from actual kitchen installations. These tests were conducted so that once and for all we could arrive at the truth: What type filter, and whose engineering and manufacturing design is the best? We undertook this expense so that we might debunk the myths that have arisen with regard to efficiency percentages as they apply to NFPA 96 grease filters.

UL and NFPA 96 are very exact in their specifications. A filter, for example, must drain off at least four times as much grease as it retains, and must prevent penetration of flames of more than fifteen inches through a grease-loaded filter. The one area that UL does not specify is the efficiency of the grease filter, and it is around this fact that many of the false impressions have been given.

Many mesh filter manufacturers, including the top rated one selected for this test series, claim efficiencies of 90+%. Let it be known to one and all that these purported high efficiencies were the results of tests conducted under conditions far different from those in the "real world", and at far less rigorous conditions than those of the Standard-Keil efficiency tests.

In actual practice, the test filter which is advertised at 90+% efficiency was observed to have grease dripping from the exhaust duct in less than three hours of test, and in the Standard-Keil test far, far less than 90% efficiency. You will note from the chart attached that the FIRE FIGHTER attained almost a 70% efficiency. These efficiencies were developed in a practical, simulated cooking situation, under strict laboratory procedures and observations. Without question, the FIRE FIGHTER out-performed both mesh and Flame Gard by a visibly wide margin.

The physical apparatus of the test is as the attached drawing shows. Tests were performed in the following manner: C.F.M. and velocities were determined by static pressure, since it is easy to read, accurate, and consistent. The static pressure/velocity relationship was determined by Air Moving and Conditioning Association Test Laboratory.

The filters were weighed before and after each test, as was the collection cup. After obtaining the required air velocity by setting the proper static pressure, oil and water were metered into the pot on the hot plate to create a grease-laden vapor. Sixteen hundred (1600) grams of oil (and about twice as much water) were dripped into the pot over a six-hour period. At the end of the test, the filters were weighed, along with the oil in the trough and cup. Residue in the pot was subtracted from the amount fed, to get the amount vaporized. This amount, divided into the total captured by the filter, gives us the efficiency percentage. The filters were washed thoroughly between each test, and reweighed to insure cleanliness. Again--test results showed conclusively the superiority of the Standard-Keil FIRE FIGHTER.

An examination of the cross section of a FIRE FIGHTER will show the reason for its high efficiency. Grease-laden air entering the front side of the filter has its velocity increased by five times, as it moves through the narrow throat openings. As the air makes directional reversals in its circuitous path, the heavier grease particles tend to go in a straight line, thus impinging on the inner surfaces of the vanes. Each reversal extracts a greater portion of the grease, and as the air exits at the rear of the filter, its velocity slows down to the entrance speed as the throat opening increases. Each vane is polished stainless steel, thus permitting the captured grease to safely drain off into a collection trough.

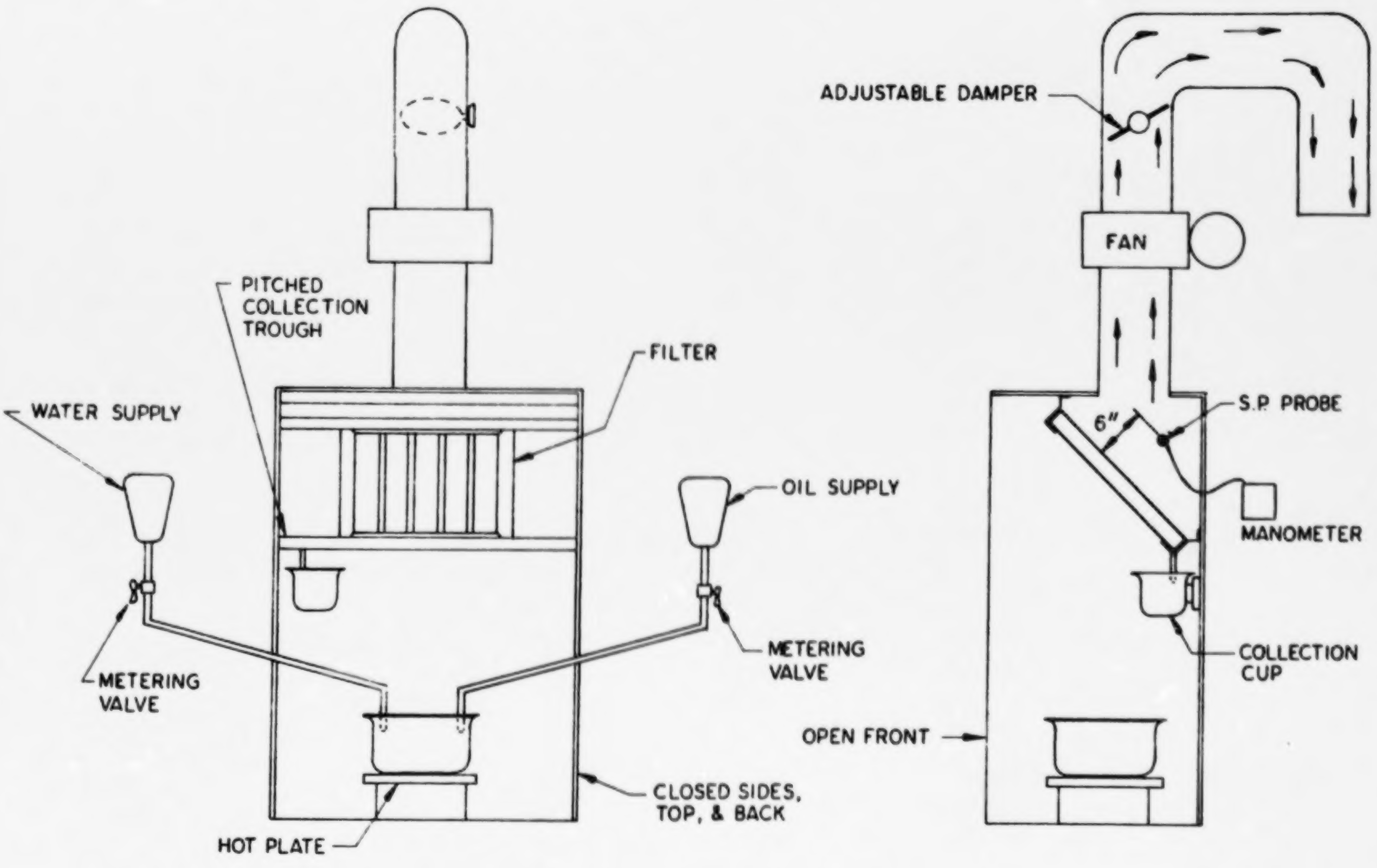
With the grease deposited away from the hood and duct, you have eliminated a prime cause of fires in kitchens. NFPA Bulletin FR74-1 1974, titled "A Study of Restaurant Fires", reveals some alarming statistics. In that year, a fire was reported in 21,000 restaurants, or approximately one out of every ten. The average damage was $2,500, but some were in excess of $250,000. Many of these fires were the result of flare-ups over deep fryers, grills, broilers, etc. These flare-ups ignite the grease that becomes stored in mesh filters, since mesh media accumulate grease and do not permit grease to run off to a safe area. The resultant massive flame spreads rapidly up the grease-coated duct work and beyond. This may occur even when fire extinguishing equipment is installed, since many systems are inoperative due to improper and/or infrequent maintenance.

The value of the new approved baffle type grease filters in preventing fires prompted NFPA in 1973 to amend its Code 96 to require that UL-listed grease filters be installed in hoods of commercial cooking equipment. With the Standard-Keil FIRE FIGHTER, you have the best of all grease filters.

INDEPENDENT TEST LABORATORY REPORT ON GREASE EXTRACTION

FILTER MAKE	VELOCITY F.P.M.	CFM PER FILTER	GREASE EVAPORATED GRAMS	GREASE COLLECTED GRAMS	PERCENTAGE
FIRE FIGHTER	200	450	1632	1066	65.3
R. P. Mesh	200	450	1650	839.5	50.9
Flame Gard	200	450	1639	700.5	42.7
FIRE FIGHTER	267	600	1638.5	1075	65.6
R. P. Mesh	267	600	1633	875	53.6
Flame Gard	267	600	1621.5	825	50.9
FIRE FIGHTER	333	750	1625.5	1072	65.9
R. P. Mesh	333	750	1610.5	813	50.5
Flame Gard	333	750	1632	820.5	50.3
FIRE FIGHTER	400	900	1629.5	1134	69.6
R. P. Mesh	400	900	1632	985	60.4
Flame Gard	400	900	1638	883	53.9

4/17/75



PITCHED
COLLECTION
TROUGH
FILTER
WATER SUPPLY
OIL SUPPLY
METERING
VALVE
METERING
VALVE
CLOSED SIDES,
TOP, & BACK
HOT PLATE
ADJUSTABLE DAMPER
FAN
6"
S.P. PROBE
MANOMETER
COLLECTION
CUP
OPEN FRONT

PHYSICAL APPARATUS USED FOR
GREASE EXTRACTION EFFICIENCY TEST
AS PERFORMED BY INDEPENDENT TESTING LABORATORY

REPORT OF TELEPHONE CONVERSATION
DIRECT MEAT FIRING INDUSTRY

DATE: 9/7/77

PERSON CALLED: __________

ORGANIZATION: Avis Eat Barbecue

ADDRESS: Faneuil Hall Market Place
Boston, Massachusetts

TEL. NO. 742-2947

GCA PERSONNEL: William Battye

SUBJECT MATTER:

Barbecue oven used by Avis Eat.

They use an electric rotissary made by

Esquire Mechanical Corp.
Brookline, NY
(212) 625-4006

REPORT OF TELEPHONE CONVERSATION
DIRECT MEAT FIRING INDUSTRY

DATE: 9/8/77

PERSON CALLED: ____________

ORGANIZATION: Fatboy's Barbecue

ADDRESS: 1505 W. King St.
Cocoa, Florida 32722

TEL. NO. (305) 636-6730

GCA PERSONNEL: William Battye

SUBJECT MATTER:

Barbecues used by Fatboy's chain.

They use the model XL from:

Rotoflex Oven Co.
San Antonio, Texas.

They have 23 locations.

REPORT OF TELEPHONE CONVERSATION

DIRECT MEAT FIRING INDUSTRY

DATE: 9/9/77

PERSON CALLED: Al Gordon

ORGANIZATION: Food Service Equipment and Design

ADDRESS: 221 N. Beacon St.
Brighton, Massachusetts

TEL. NO. (617) 254-0400

GCA PERSONNEL: William Battye

SUBJECT MATTER:

Barbecues sold by Food Service.

They will send literature about gas and electric-fired charbroilers.

REPORT OF TELEPHONE CONVERSATION
DIRECT MEAT FIRING INDUSTRY

DATE: 9/9/77

PERSON CALLED: __________

ORGANIZATION: Cactus Barbecue

ADDRESS: __________
Jacksonville, Florida

TEL. NO. (904) 765-3016

GCA PERSONNEL: William Battye

SUBJECT MATTER:

Barbecue ovens used by Cactus Restaurants.

They use pots with hickory wood buring.

Wood is suspended 4 feet above the coals.

REPORT OF TELEPHONE CONVERSATION

DIRECT MEAT FIRING INDUSTRY

DATE: 9/12/77

PERSON CALLED: ______________________

ORGANIZATION: Rotoflex Oven Company

ADDRESS: ______________________

San Antonio, Texas

TEL. NO. (512) 222-2278

GCA PERSONNEL: William Battye

SUBJECT MATTER:

Barbecues for restaurants sold by Rotoflex.

They have sent information about their barbecue ovens.

REPORT OF TELEPHONE CONVERSATION
DIRECT MEAT FIRING INDUSTRY

DATE: 9/19/78

PERSON CALLED: Annette Cadwell

ORGANIZATION: National Restaurant Association

ADDRESS:

Chicago, Illinois

TEL. NO. (312) 787-2525

GCA PERSONNEL: William Battye

SUBJECT MATTER:

They agreed to send a list of vendors of barbecue equipment and some information about the barbecue operation.

REPORT OF TELEPHONE CONVERSATION
DIRECT MEAT FIRING INDUSTRY

DATE: 9/20/77

PERSON CALLED: Harvey Edlin

ORGANIZATION: Harvey Edlin Sales

ADDRESS:

Woburn, Massachusetts

TEL. NO. (617) 527-6083

GCA PERSONNEL: William Battye

SUBJECT MATTER:

Barbecue ovens sold by Harvey Edlin Sales to restaurants.

They sell only electric rotissaries.

REPORT OF TELEPHONE CONVERSATION
DIRECT MEAT FIRING INDUSTRY

DATE: 9/20/77

PERSON CALLED: ____________

ORGANIZATION: Underwood's Food

ADDRESS: 1208 East Davidson St.
Arlington, Texas 76011

TEL. NO. (817) 261-1016

GCA PERSONNEL: William Battye

SUBJECT MATTER:

Barbecue ovens used by the Underwood Barbecue chain.

There are seven locations of the Underwood chain, each of which uses about 1-1/2 cords of wood per month. The ovens are 17' long and 3-1/2' wide, and have two separate compartments for the meat and the wood. Smoke from the wood is vented into the meat compartment.

REPORT OF TELEPHONE CONVERSATION
DIRECT MEAT FIRING INDUSTRY

DATE: 9/21/77

PERSON CALLED: ______________________

ORGANIZATION: Smoker Products Inc.

ADDRESS: Highway 175 East
Mabank, Texas 75147

TEL. NO. (214) 887-9681

GCA PERSONNEL: William Battye

SUBJECT MATTER:

Barbecue ovens marketed by Smoker Products for the restaurant industry.

Smoker has sent written material on its barbecue ovens.

REPORT OF TELEPHONE CONVERSATION

DIRECT MEAT FIRING INDUSTRY

DATE: 9/21/77

PERSON CALLED: ______

ORGANIZATION: Kronos Foods Inc.

ADDRESS: 940 West Fulton St.
Chicago, Illinois 60607

TEL. NO. (312) 226-1214

GCA PERSONNEL: William Battye

SUBJECT MATTER:

Barbecue ovens sold by Kronos to restaurants.

Kronos sells broilers which cook truncated cones of meat on spits over coals. They will send written material for these broilers.

REPORT OF TELEPHONE CONVERSATION
DIRECT MEAT FIRING INDUSTRY

DATE: 9/21/77

PERSON CALLED: ________________

ORGANIZATION: Holstein Manufacturing Inc.

ADDRESS: P.O. Box 135
Holstein, Iowa 51025

TEL. NO. (712) 368-4342

GCA PERSONNEL: William Battye

SUBJECT MATTER:

Barbecue ovens sold by Holstein to restaurants.

They have sent written material on their barbecue ovens.

REPORT OF TELEPHONE CONVERSATION
DIRECT MEAT FIRING INDUSTRY

DATE: 9/21/77

PERSON CALLED: Charlie Wade

ORGANIZATION: Kook Rite Kooker Sales

ADDRESS: P.O. Box 1010
Mooresville, N.C. 28115

TEL. NO. (704) 664-4561

GCA PERSONNEL: William Battye

SUBJECT MATTER:

Barbecue ovens sold by Kook Rite Kooker Sales to restaurants.

Kook Rite sells ovens which use infrared heaters on the top and bottom of the meat, and a charred piece of Hickory which is also heated by the heaters to give off smoke to flavor the meat. They have sent written material on these ovens.

REPORT OF TELEPHONE CONVERSATION

DIRECT MEAT FIRING INDUSTRY

DATE: 9/22/77

PERSON CALLED:

ORGANIZATION: J and R Manufacturing

ADDRESS: P.O. Box 522/933 Dalworth
Mesquite, Texas 75149

TEL. NO. (214) 285-4855

GCA PERSONNEL: William Battye

SUBJECT MATTER:

Barbecue ovens marketed by J&R for restaurants.

J&R sells the "Oiler barbecue pit," which is 5 feet wide, 8 feet - 8 inches long, and 6 feet - 3 inches high, and weighs 3800 lbs. It has a capacity of 350 lbs. of meat. The "pit" is a free standing structure made of refractory material, with 2 inches of fiberglass insulation on the outer surface. It contains two compartments, one where wood is burned, and one where meat is cooked. The smoke from the fire compartment is vented through the cooking oven. Meat is usually cooked for 14 hours at 200 to 250° F. J&R has sent written material about this product.

REPORT OF TELEPHONE CONVERSATION
DIRECT MEAT FIRING INDUSTRY

DATE: 9/22/77

PERSON CALLED: ____________

ORGANIZATION: Abbot Products Inc.

ADDRESS: 3307 South Lawndale
Chicago, Illinois 60623

TEL. NO. (312) 376-7655

CCA PERSONNEL: William Battye

SUBJECT MATTER:

Barbecue ovens marketed by Abbot for restaurants.

Abbot sells small gas and electric rotissaries for cooking meat for sandwich shops. The largest model is only 18 inches high and has a capacity of 15 lbs. of meat. In the gas rotissary, the meat is usually in contact with the flame.

SEARS-WESTALL COMPANY
702 HANLEY INDUSTRIAL COURT / ST. LOUIS. MO. 63144 / (314) 645-7890

POLLUTION CONTROL/PROCESSING EQUIPMENT/AND BULK MATERIALS HANDLING

September 27, 1977

Mr. Phil McLellan
GCA Technology
Burlington Road
Bedford, Massachusetts 01730

Dear Mr. McLellan:

It has just come to my attention, that you were not furnished information relative to our fume incinerator. We had received a call from you in June requesting this information. It is with my apologies that you did not receive it. In truth, I feel that their was an effort to furnish you with much more elaborate presentation than accompanies this letter.

Sears-Westall Company was asked to wreck the fumes from a local barbecue 25 years ago. At that time, through today, we were involved in the sale of Venturi Scrubbers. We originally felt that the scrubber was an ideal solution to the smoke from this barbecue pit. We installed a unit only to find that it was not the solution and that the problem was not a simple one.

During 1968 and 1969, we were building large 25,000 and 50,000 CFM cast hard fume incinerators. These units were approved and inspected by our local Air Pollution Control Authorities.

This local authority after having inspected one of our industrial fume incinerators, asked us to review the requirements of a local char-broiling restaurant. We did so reluctantly, but from this grew our restaurant fume extinguisher. The original unit is still in operation and performs as it must each day. We have many units, but most of our restaurant effort has been located in St. Louis, St. Louis County and Kansas City. The name fume extinguisher was arrived at due to the difficulties in getting anyone to view a building permit for a fume incinerator installed in or around a restaurant.

We have many units, as is our original, with the flame installed at the top of the hood, thus eliminating need for filters within the hood itself. The duct thus remains clean. However, this offers a problem in selection of a fan to handle the hot fumes.

Since we are discussing hot fumes, it should be brought to your attention that we pass our fumes directly through the flame and they bring the oxygen to the gas without additional air. Ours then is a raw gas burner that can stand steady in high villosity ducts. We have number installed at 2500 to 3000 feet/minute villosity passing directly through the Venturi design of our raw gas burner. The burner is the most efficient unit on the market and is our only reason for remaining in the industry.

Our designs are very flexible to meet any specific restaurant need. On the practical side, it has been learned through years of experience, the restaurant owner and operator prefers the burner downstream of his fan. This is because he has for years understood the operation of his filters, ducts and exhaust fan. It is the easiest to add our unit to this chain, thus, without bringing any new equipment to focus on his overall system design. Our unit does replace the normal mushroom fan with a squirel cage fan directing the fume at the discharge of the fan, through our burner. The smoke and grease laden fumes mix with and are part of the flame as it passes through the burner to discharge.

All of our units are designed to give a differential temperature of 1,000 to 1,400° depending on the local code requirements. We have this capability, but know of no unit operating at a discharge above 400° F. We have taken temperatures of most all of our original units to determine optimum operating temperatures. At the temperature that we mention here, we have cleared the discharge stack to a zero Ringlemann.

Most of our installations have been due to neighbor complaints relative to odor. We have installed all of our units with success in satisfying these complaints. We would be remiss if we led you to believe that we removed all odor. It has been estimated that we do reduce this odor 95%, but there is still a detection of odor which has been acceptable by all parties.

The pit barbecue offers the greatest challenge. This is greater than that offered by a char-broiling restaurant. The pit barbecue when successful creates a huge volume of fat laden smoke fumes that coat the pit walls. The fume is also very low in oxygen but there are many conditions of its operation. It is also to be pointed out that the barbecue pit operator burns his unit out either once a day or at least once a week. To do this he builds a huge fire normally fueled with boxes, paper and so forth. This gets the pit hot enough to ignite the greases that cover the walls and stack of his pit.

It is this burn out condition that destroys conventional fume abatement systems as well as giving us our share of schooling.

Due to this burn out condition in barbecue pits, we are reluctant to install anything but vertical units. This allows any ash to fall directly back to the pit and not foul or fill a system. All barbecue units are of natural draft design. On pit barbecues, we have measured discharge temperatures in access of 1400° during their peak cooking cycles. We are however, are only adding approximately 400° to this discharge temperature.

We have reviewed many designs of restaurant fume systems offered the very gullible restaurant market. Each restaurateur is ready for a new gimmick, sometimes even at more money. The fact remains that these fatty oils and greases must be either collected or consumed. If they are collected such as evidence in an electrostatic precipitator or filter system, they must be removed from the collector. Charred pieces are tar-like in their consistency and in time destroy the efficiency of most systems. Again, the fats are collected they must be cleaned from the system and this offers a labor time consuming process to restaurant personnel. The collected greases become an extreme fire hazard and in the case of a high volume char-broiling operation or the pit barbecue a very dangerous operating condition.

The particles to be collected are at most too small to be collected in conventional scrubbers. After they are collected, they again, must be removed, offering still further pollution control problems.

In the most part, conventional fume incineration systems utilize a standard burner blower package that sends a flame into a box. The blower is subject to back pressures and the flame is weak and most often bent by the fume from entering and mixing with it. The success of these units are normally through radiation not direct contact of the flame. Noise pollution has often been an unexpected problem for installation of many of the units.

Owing to the fact, that many of our units must be installed on wooden roofs or under ceilings, we utilize a space age refractory. We pay a higher price for a quality product that offers the industry a light weight unit of a design that best fits their application. You will note that our units are normally approximately 2' x 2' in cross section. All units are fitted with rain caps or hoods.

I'm sure that you are aware that we are enclosing a number of sketches and a paper that we presented at the 1970 meeting of the Air Pollution Control Association. We have made several penned comments in the border of this paper. We thank you for your interest in our fume extinguisher for restaurant and barbecue applications. Should you desire more detailed information, please do not hesitate to contact us.

Very truly yours,

SEARS-WESTALL COMPANY

George B. Westall, Jr.

George B. Westall, Jr.

GBW:dw
Enclosures

CHAR - BROILERS & BAR-B-QUERS

Eliminate FIRE HAZARD and AIR POLLUTION PROBLEMS

PROBLEM

Char-Broiling restaurants emit a dense smoke filled exhaust from their broiler. This smoke is a fine aerosol mist of organic fat that carries a distinct odor. With the establishment of Air Pollution Control Authorities, char-broiling restaurants were cited as offenders of the codes. In many areas alerted citizens pressed for the enforcement of these codes against the char-broilers and barbecuers.

Restaurant operators would like to be good neighbors and correct their exhaust stacks. The problem, however, is not just one of air pollution but one of continuing concern to the restaurant's operation. Fumes drawn from the char-broiler are drawn into the exhaust system, depositing great amounts of grease throughout the duct work. These ducts are always a concern as a possible source of fire and damage to the restaurant and its contents.

The immediate problem is to satisfy the local Air Pollution Control Authorities and as much as possible, eliminate the fire hazard caused by grease deposits throughout the duct work.

FILTER FALLACY

Most char-broiling restaurants have filters installed in the exhaust hood to remove grease particles as they are drawn from the pit. These filters catch large grease particles while passing smoke laden fumes to the ducts and fan. The hood filters are not designed for the collection of the vapor or submicron fogs and mists. With recorded hood exhaust temperatures from gas fired char-broiling grills at 300°F. most oil fat will pass the filter and remain as a vapor. Condensed oils and vapors are first of submicron size and coalesce to layer particles as they are cooled. Those particles coalescing accumulate on the ducts and at the fan. The smoke exhausted from the stack is made up of these small particles as they enter the air.

The unseen submicron particles are carried further and tend to float in the air stream. This is the odor particle which enters your closed car or home. This submicron particle is the most troublesome to collect due to its size and chemical content. Positive filters of tight porosity to collect these submicron particles are quickly coated and fouled. They are similar to your coffee filters.

WATER SCRUBBER ATTEMPT

Restaurants first followed their hood filters with water scrubbers that were of many different configurations. Water cools, coalesces and knocks down the grease and smoke. Experience has proven that the water scrubber on barbecue or char-broiling restaurants furnishes little solution for removing odors or clearing the stack. Beyond the scrubber, the ducts and fan collect even greater amounts of greases and increase the hazards.

ELECTROSTATIC PRECIPITATOR EXPOSED

Charred fats and greases are electronically charged to be attracted by collector plates of opposite polarity. When the electron emitting wires or the collecting plates are coated their efficiency and effectiveness stops. The grease tars collect within the electrical field causing further hazards.

BEDFORD FUME EXTINGUISHER—THE SOLUTION—A CLEAR STACK

The hood mounted near maintenance-free Bedford "FUME EXTINGUISHER" eliminates air pollution and the fire hazard of the grease laden exhaust system. The organic and charred grease vapors and smoke are consumed and converted in the "FUME EXTINGUISHER" to the products of combustion, carbon dioxide and water vapor. The result is a clear stack meeting the requirement of all Air Pollution Control Authorities.

GUARANTEE

The Bedford Industries FUME EXTINGUISHER is guaranteed to meet the most difficult requirements present and future of your local Air Pollution Control Authority.

NOTE: YOU SHOULD ONLY BUY EQUIPMENT WITH A PERFORMANCE GUARANTEED TO MEET YOUR PRESENT AND POSSIBLE FUTURE CODE REQUIREMENTS.

INSTALLATION CAN BE PERFORMED BY LOCAL CONTRACTORS

FORMERLY SEARS-WESTALL COMPANY

[redacted]
702 HANLEY INDUSTRIAL COURT
(314)-645-7890
ST. LOUIS, MO. 62144

SEARS-WESTALL COMPANY
PROCESS EQUIPMENT
702 Hanley Industrial Court
St. Louis, Missouri 63144
314-645-7890

GCA/TECHNOLOGY DIVISION ●●▲

To

Date 23 June 1977

From Mark Bornstein

Subject Trip Report - National Restaurant Association Show, May 23-24, 1977
McCormick Place, Chicago, Illinois

The National Restaurant Association held their annual show in Chicago. Approximately 800 exhibitors including charbroil equipment manufacturers and control equipment manufacturers were represented at the show. All exhibitors provided literature on their products and in most cases a demonstration unit was also available for inspection.

The following companies were visited by GCA for the purpose of obtaining further information about the direct meat-firing industry.

- Anetsberger Brothers, Northbrook, Ill. - Mr. Ed Zeman. Manufacturer of charbroilers. Mr. Zeman was not able to provide me with an estimate of the number of units in the country or the number of units they have sold. Their units are designed only to use gas as a fuel.
- Ember-Glo, Chicago, Ill.- Mr. Leon Berkowitz. Ember-Glo manufacturers an electric charbrand griddle which is not a charbroiler but which could be used in place of a charbroiler. This unit imparts the same appearance to a piece of meat as does a charbroiler, but the taste is slightly different. This unit which costs under $900.00 could possibly be used in place of a charbroiler thus avoiding any additional costs associated with control equipment. (These costs could be several thousands of dollars.) The term used by the industry to describe this type of unit is "Groovy Griddle."
- Bakers Pride, Bronx, N.Y. - Mr. Nevins, President. Mr. Nevins told me that Bakers Pride is the largest manufacturer of charbroilers with sales capturing 70 percent of the market; however, business over the last 3 years has dropped dramatically by 75 to 80 percent. He estimates that approximately 100,000 units have been sold over the past 30 years. The average life expectancy of a unit is approximately 6 or 7 years. Therefore, as a first approximation, at least 20,000 units are presently operating which were manufactured by Bakers Pride.
- Electro-Air, Harrison, Arkansas - Mr. Richard Murphy. Electro Air manufactures a self-cleaning electrostatic precipitator (ESP).

Mr. Murphy was very willing to discuss his product and its potentials. Apparently, they would more than appreciate a new federal regulation on the direct meat-firing industry since business would increase dramatically. Presently very few restaurants are purchasing any type of control because there is no pressure from the local or state regulatory agencies. Their ESP is designed to be 90 percent efficient for particles down to .03 microns and will continuously maintain opacity below 20 percent. I requested from the company any data or tests to back up their claim on efficiency. Mr. Murphy stated that he will provide this information at a later date. To help in the marketing of their ESP Electro-Air has hired a consulting firm by the name of Lester B. Knight Co. to study the charbroil restaurant industry. Mr. Bob McFee from this firm will contact me in the future to discuss the possibility of exchanging notes.

Cost data was provided by Electro Air during the show. A 6000 cfm unit will cost approximately $7000 to purchase. Total operating are approximately $80/month with the detergent costing about $45/month. If the unit is properly maintained, which can be a problem in the restaurant industry, the unit will work as designed.

- United Air Specialists (UAS) - Cincinnati, Ohio - Mr. David Chrisman UAS manufactures an electrostatic precipitator which they market under the name "Smokeeter." This unit is not self-cleaning. The cells have to be taken out manually and washed in detergent. The units are sold in modules of 2000 cfm at a cost of about $2.00 per cfm. Operating costs for a 6000 cfm unit are approximately $150 annually. This system has been used in several restaurants, all of which have been successful.

- SECO - St. Louis, Missouri - Mr. Bernie Stever. SECO primarily designs and installs hooding systems for restaurants. They usually use ESP manufactured by Electro-Air. The temperature of the exhaust gases from their system is approximately 110 to 120° F, which can be considered normal for almost any charbroiler.

- Ventroguard - Nashville, Tenn. - Mr. Don Tritten. This firm manufactures an exhaust system that extracts grease and saves on heating and air conditioning costs. No data are available concerning its smoke removal efficiency. The cost of the unit is approximately $1500 per linear foot.

- Wolf Range - Compton, California - Mr. Bill Carpenter. Wolf Range is a major manufacturer of charbroilers. Bill estimated that the annual growth rate for the next several years should be between 5 and 10 percent. Their units if properly maintained will last 10 to 15 years at a minimum. Wolf Range also manufactures the "Groovy Griddle" at a cost of about 10 percent higher than a conventional broiler.

- Vulcan-Hart - Baltimore, Maryland. Vulcan-Hart manufactures several different types of charbroilers both gas and electric. Their units range in price from a low of $550 to several thousand dollars. The electric unit costs approximately $1500.

- Magikitch'n Equipment Corp., Quakertown, Penn. - Mr. Weyland. This firm manufactures charbroilers primarily gas-fired. Mr. Weyland estimates that 10 to 15 percent of all restaurants have a charbroiler. Salamanders are used in 5 percent of the restaurants with the remainder being countertop models.

- Molitor Inc. - Englewood, CA - Mr. Arlen Gallagher. Molitor manufactures a control device called the "Moli-tron Total/Aire System." This system was also designed so as to save on heating and cooling costs. The system is primarily a water wash scrubber in conjunction with a heat recovery system. The estimated payback period is 1 to 1-1/2 years when electric heating is used and 4 to 5 years when natural gas is used. No data were available on its efficiency but Mr. Gallagher promised to mail me further information.

GCA/TECHNOLOGY DIVISION

TO: File 1-614-012

DATE: 5 July 1977

FROM: Mark Bornstein

SUBJECT: Trip Reports - Meetings at Aero-Dyne Manufacturing Inc., and Hardee's Food Systems Inc.

Mr. Cliff Culpepper represented the Aero-Dyne Company, manufacturers of complete air pollution control systems for restaurants. This firm, which has existed for approximately 10 years, produces a mini afterburner which is used in conjunction with their low volume hood and grease extractor. At the meeting a discussion was held concerning the type of emissions resulting from open grills and the different methods available for controlling them. The major difference between this firm's afterburner and other systems is the specially designed hood. Flow rates can be reduced by a factor of 2 or 3 from conventional hooding systems. The average cost for a complete package is approximately $8,000. This includes the hood, fan, duct work, grease extractor, fire extinguisher system, control panel afterburner and hood lighting. Based on a flow rate of 750 cfm, which is about half of a normal system, an operating temperature of 500°F. and 5 hours of use per day, the system will use 500,000 ft.^{3} of natural gas per year costing approximately $1,200. According to Mr. Culpepper, this system will remove all visible emissions and all odor.

Hardee's Food Systems was visited during the afternoon. The following people attended this meeting:

Mr. James Moore, Vice President, Hardee's Food Systems, Inc.

Mr. William Herring, U. S. EPA

Mr. Mark Bornstein, GCA

Mr. Larry Stahl, who was originally scheduled to represent Hardee's was not present due to a misunderstanding during our arrangement of the meeting. However, Mr. Moore met with us for a short time and explained the operation of their control device called the "Conqueror."

The "Conqueror" consists of a Monsanto Brink® mist eliminator used in conjunction with a Gaylord grease extractor. Emissions from the charbroiler first enter the Gaylord hood. Air flow rate into the hood is limited to 1750 ACFM by plates (economizers) that confine air entry to the area directly above the grill. A water spray is added at the transition section where the hood and mist eliminator meet. This spray evaporates and is used to cool the incoming gases. The air then passes outwardly through the glass fiber pad and is exhausted to the annular space between the mist eliminator and the housing. It is then vented by a duct to the 5 horsepower fan where it enters the atmosphere.

At night, after the close of business, the mist eliminator is washed with a strong caustic aqueous spray. It then goes through a soak period before it is rinsed with cold water. The sprays are applied through a wash rack using nozzles. The Gaylord hood is cleaned the next morning using hot detergent water. The pressure drop across the system is normally 5 to 6 inches of water but will be higher immediately after it is washed. As the system dries the pressure drop will return to normal. Some operational problems have been experienced, primarily from the application of hot water which forms a scale on the interior surfaces. This problem will be solved on future models. For further information Mr. Moore suggested that I call Mr. Larry Stahl.

Mark Bornstein

MB:clps

GCA/TECHNOLOGY DIVISION

To

Date 28 July 1977

From M. Bornsteain

Subject Trip Report - Kansas City, Missouri
Mr. George De Lapp

I. PURPOSE

To meet Mr. George De Lapp, Supervisor/Enforcement, Air Quality Section, City of Kansas City, Missouri, to inspect several direct meat-firing facilities and to obtain performance data on existing facilities with control equipment.

II. PLACES VISITED AND TYPE OF CONTROL

a. Fire Side Inn
5500 N.E. Antioch Road
Control - American Environmental Systems - afterburner

b. Hardee's
2825 N.E. Vivion
Control - Sears Westall - afterburner

c. Denny's
3910 Main St.
Control - process modification - Groove Griddle

d. Arthur Bryant's Barbecue
1727 Brooklyn
Control - Sears Westall - afterburner

e. Golden Ox Restaurant
1650 Genessee
Control - Sears Westall - afterburner

f. Smugglers Inn
1650 North University Dr.
Control - United Air Specialist - electrostatic precipitator

g. Herefore House
2 East 20th St.
Future control - Drexel Carlson Co. - Airgiene vapo-reactor

III. DISCUSSION

A brief description of each facility and their associated control equipment is presented below.

a. Fire Side Inn - full restaurant

Mr. H. Terry, Manager of the restaurant, provided us with a visit of his facility. There are three gas-fired charbroilers in the kitchen; however, only two are usually used at any one time. Each unit is approximately 3 feet in length. A 6-foot hood with a flow rate of 3000 CFM services the two charbroilers. Besides the three gas-fired broilers there are also three gas-fired ovens, and a deep broiler. The charbroilers are presently controlled by an American Environmental System afterburner. The installed cost of the afterburner was approximately $12,000 (date installed September 1972). The unit itself costs about $9500. The unit is run continuously from 10:00 in the morning to midnight (14 hours/day). Although it does not have to be run during slack periods it is still kept on to avoid plugging of the afterburner. Mr. Terry stated that his gas bill for June was approximately $400 which included the three charbroilers, the three ovens, the deep broiler, a 300 gallon hot water heater and the afterburner. An estimate for the cost of gas to operate the afterburner is approximately $200 per month. The peak periods of operation during a typical day are from 12:00 noon to 1:00 p.m. and from 7:30 p.m. to 8:30 p.m.

According to Mr. De Lapp the system works satisfactorily with no visible emissions or odor present. Our visit to the roof confirmed the effectiveness of the system. No actual stack tests, however, have been performed. The afterburner has a maximum firing rate of 800,000 Btu/hr.

b. Hardee's - fast food

Mr. Norman Kaufman, Manager of the restaurant, provided background information on the operation of his facility. The restaurant is normally open from 9:30 a.m. to 11:00 p.m. An afterburner manufactured by Sears Westall with an operating rate of 550,000 Btu/hr is used to control emissions from the two charbroilers. Each gas-fired charbroiler is approximately 3 feet in length. The air flow rate through the hood is approximately 1800 to 2000 cfm. A Fairchild hood is used without any water wash system. Mr. Kaufman estimated that about 100 to 150 lbs. of hamburger per hour is cooked on the charbroilers during the peak period. The total gas bill for May was $800 which included: two charbroilers, two deep freezes, hot water and the afterburner. Approximately $500 per month may be attributed to the afterburner.

c. Denny's - fast food

Denny's did not use a charbroiler but a groove griddle. Mr. De Lapp stated that his agency has approved the use of the groove griddle since emissions from this type of operation are almost negligible. Because this particular Denny's was located near an adult entertainment section of town the peak operating hours were different from most other restaurants. The lunchtime peak occurred between 12:00 noon and 2:00 in the afternoon while the dinner peak did not take place until from 12:00 midnight to 3:00 a.m. The reason for the late night peak period was due to the closing of bars in the area resulting in Denny's being the only major restaurant open in the area at that time of night. Approximately 36 pounds of hamburger and steaks are grilled over the 2-hour lunch period. No estimate of meat consumption was available for the late night peak period. During our visit no visible emissions were noticed coming from the roof of the restaurant.

d. Arthur Bryant Barbecue - fast food

Mr. Bryant operates a wood-fired barbecue for cooking meats. Approximately 1 ton of meat is cooked each day consuming approximately 1 cord of wood. The restaurant is open from 8:00 a.m. until 7:00 p.m. and is normally busy all day with a major peak between 11:00 a.m. and 1:00 p.m. A Sears Westall afterburner is used to control emissions from the facility. The total gas bill for the month of June was $800 which included the afterburner, a small incinerator, a deep fryer and a hot water heater. It is estimated that the afterburner uses approximately $700 worth of natural gas per month. While on the roof of the restaurant, a small amount of visible emissions was noticeable. This may be due to a small blower not functioning which supplied additional combustion air. The afterburner which was designed by Sears Westall operates at a normal rate of 1,000,000 Btu/hr; however, during cleanup or during abnormal conditions the unit has the capability of reaching 2,000,000 Btu/hr.

e. Golden Ox - full restaurant

Mr. Harold Thomson, Manager, provided information concerning the operation of his restaurant. This facility has three charcoal-fired broilers. The operating hours are from 11:30 a.m. to 10:00 p.m. The peak period for lunch is from 11:30 to 1:00 p.m. and the peak period for dinner is from 6:00 p.m. to 8:30 p.m. Mr. Thomson stated that the cooking of hamburgers will cause more emissions than the cooking of steaks. During lunch approximately 25 to 30 percent (65 lbs.) of the total meat cooked (225 lbs.) is hamburger. However, during dinner only 2 percent (5 lbs.) of the total meat cooked (250 lbs.) is hamburger. A Sears Westall afterburner with a maximum capacity of 1,200,000 Btu/hr for each of three burners is used to control the emissions. The unit is only operated for 7 hours per day, since it is not used during the slack period between 2:00 and 5:30 p.m. It was estimated that the average monthly bill for the operation of this unit is $350. The flow rate through the unit is approximately 6000 cfm.

f. Smugglers Inn - full restaurant

The restaurant Manager, Mr. Brian Hook, provided background information concerning the operation of his restaurant. One 24-inch by 48-inch gas-fired charbroiler is used in the kitchen. An electrostatic precipitator manufactured by United Air Specialist (UAS) is used to control emissions. Mr. Hook estimated that a 55-gallon drum of detergent, which costs $400, lasts from 3-1/2 to 4 months. The cost of electricity to operate the precipitator is negligible. The only other associated cost is the water used during the daily cleaning. Unlike an afterburner this system will generate a liquid waste stream; however, the amount generated is small compared to the other restaurant operations (dishwasher, general cleaning, etc.). UAS will be contacted to obtain water consumption rates.

The two peak periods of operation for this restaurant occur between 11:30 a.m. and 2:00 p.m. and between 6:00 p.m. and 10:00 p.m. An average total usage of meat during the day is 300 pounds, of which 50 lbs. is cooked for lunch and the remaining 250 pounds is cooked for dinner. The major portion of this meat is hamburger. A hood approximately 12 feet in length is used over the charbroiler, the deep fryers, the bun warmer, and a flat griddle. The flow rate through the hood is approximately 4000 cfm.

g. Hereford House - full restaurant

Mr. Jack Webb, owner of the Hereford House, discussed the operation of his restaurant with Mr. De Lapp and myself. Data provided by the National Restaurant Association concerning three tests performed at the restaurant were supplemented with additional information by Mr. Webb. The charcoal-fired charbroiler is approximately 6 feet in length and consumes approximately 120 pounds per day of charcoal briquettes. There are two peak periods of operation during the day at the restaurant. The lunch or hamburger period occurs from 12:00 to 2:30 p.m. and the supper or steak period occurs from 6:00 p.m. to 8:30 p.m. This restaurant presently does not have any control equipment but is in the process of signing a contract with the Drexel T. Carlson Company for the installation of their unit called the "Air-giene." This unit will control the total flow rate of approximately 4500 dry standard cubic feet per minute (dscfm). A pilot plant model with a flow rate of 1000 dscfm was previously tested on the restaurant and has shown to be effective in removing visible emissions. The costs of operating the unit for 1 year are $1450 for electricity (this represents only a 100 percent increase over the uncontrolled cost), $80 for water, $40 sewer charge, and $150 for chemicals. The unit will run 12 hours per day, 365 days per year. Presently, during the lunch peak period the restaurant is in violation of the general process weight curve. This is probably due to the heavy load of hamburgers that are cooked during this period.